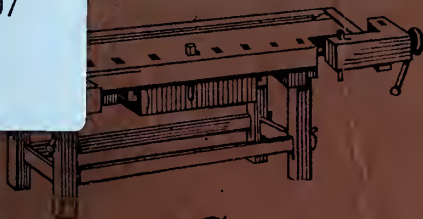


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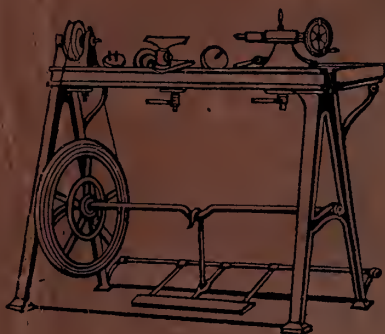
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P. N. HASLUCK.

LONDON,

October, 1890.

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THE
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CHAPTER I.

INTRODUCTION.—WOODS USED.

THE cabinet-maker deals with hard and fancy woods, and it is in these materials that the amateur handicraftsman usually finds delight in making boxes, desks, cabinets, and other useful articles, to ornament the house. A cabinet-maker makes most of the wooden articles that furnish the house, whether for use or simply for ornament, and some of his works are neither small nor very fanciful. However, it is principally small and moderate-sized work that will interest us in this handybook.

Cabinet-work is divided into sections, such as carcase-work, which includes all those pieces of furniture having holding or storing capacity, such as sideboards, wardrobes, book-cases, chests, etc.; chair-work, which includes those articles that come into the hands of the upholsterer, such as chairs, sofas, couches, stools, etc.; tables also are included under the head of chair-work.

The charm of working wood is wonderful. Almost all boys, as soon as they can talk, want knives to hack wood with, and it is certainly equally imperative that a boy should have his tool chest as that a girl should have her work-box. A very large

section of the youth and manhood of this country find recreation in wood working, to greater or less usefulness ; so much so, that cottage, villa, and mansion are often found to be furnished with the amateur's bench and a small kit of tools. The owners have not the remotest intention of ever earning their living by making chairs and tables, but they derive a pleasing, healthful, and profitable pastime, from the use of tools.

Under these circumstances some practical information on the different woods and their properties and the purposes for which they are best suited ; on the tools, how to use and how to keep them in order ; followed by minute directions for making certain small articles, will be acceptable. Processes will be gone through, and a few designs and general directions given ; but a cabinet-maker must be able to make his own designs.

Here let us consider for a moment the system of production as practised in the manufacturers' workshops. In large workshops, and especially in the factories with large capital that have in recent years sprung up, a large proportion of the work is done by machinery and the labour of the artisan is divided, so that one man executes only one part of the article being constructed, and it passes through several hands before being completed, each doing only a small share of the whole. Most of the large workshops make only either carcase-work or chair-work, and the workman is trained to the one or the other. If he is a carcase maker, he knows nothing of chair-work, and *vice versa*, and some learn only to attend to a machine.

The order of procedure in the following pages is : notes of the principal woods used in cabinet-making ; descriptions of the most approved form of benches, with sundry appliances belonging to them ; descriptions of various indispensable tools, with a suitable chest in which to keep them ; practical cabinet work is included, with directions how to choose suitable wood

for the work proposed, how to line it out before sawing, the manner of planing, squaring, gauging, drawing in, etc. Then we will make some very simple articles and progress onwards to more elaborate, as far as space allows, the first consideration being the explanations of principles and processes which can be applied to various works.

Timber first comes into the market as logs and baulks, which are measured by means of the calipers, applied by the measurers in such a manner as to get a fair average size; this is called caliper measure. String measure is to apply the tape at three or four parts in the length of the timber in order to get an average circumference. Logs and baulks are also sold by the load of 40 or 50 cubic feet, as well as at per foot cube, and large-sized timber costs more in proportion than average sizes.

Converting logs and baulks into scantlings, boards, battens, etc., is now done almost entirely by machinery, the same engine frequently working the saw, planing machine, mortising and dovetailing machine, etc.; or a universal joiner is used, which performs many of the operations formerly executed by hand.

The meanings of the terms used to describe converted or sawn timber may be explained as follows: Scantlings may be of any dimensions not those defining special sizes. Planks, deals, and battens are all $2\frac{1}{2}$ in. or 3 in. thick and respectively 11 in., 9 in. and 7 in. wide. Either of these when sawn into slices of any thickness, forms boards. Quartering is made by sawing either of the above into four strips, which approach to a square section, being from $2\frac{1}{2}$ in. or 3 in. one side and $2\frac{3}{4}$ in. or $2\frac{1}{4}$ in. or $1\frac{3}{4}$ in. the other.

Sawing is measured at per dozen cuts, according to the length of the batten, deal, or plank required to be converted into boards. If scantlings or quartering is required, then the

cuts are flat—that is, the flat way of the timber—and are measured at per 100 ft. run, according to the thickness of the stuff.

Fir timber logs are charged at per load, up to 50 ft. long, as either under or over 12 in. deep, and 3 or 4 cuts to the load; cross cuts at so much each.

Pitch pine logs are sawn at per 100 ft. super., up to 50 ft. long and up to 24 in. deep, and additional price for every 6 in. extra depth beyond 24 in.; cross cuts at about $1\frac{1}{2}$ times the price of fir timber cross cuts. Arris cuts are about a third more than flat cuts. Sometimes cross cuts are charged at per inch run, or at 6 times the amount of flat cuts, and in some cases they are reckoned as equal to 5 in. of flat cutting each.

Hardwood sawing is measured at per 100 ft. super., the price increasing with the depth, and cross cuts being charged at so much each. Very thin boards in hard woods are charged at special rates.

Planing by machinery, and also grooving, is charged at per board, floor boards prepared at per 100 ft. run, planing large timbers at per foot super.

Timber is sold by the standard, by the load, or by the square of 100 ft. super. There are several standards in use, as follows:—

London 120 pieces 12 ft. long, 9 in. $\times$ 3 in.

Petersburg 120 „ 6 ft. long, 11 in. $\times$ 3 in.

Christiania 120 „ 11 ft. long, 9 in. $\times$ $1\frac{1}{4}$ in.

The Petersburg standard is the one most generally followed, and equals 165 ft. cube; a load of timber is 50 cubic feet (hewn), so that there will be $3\frac{3}{10}$ loads in a standard. It will simplify calculations, when dealing in timber, if we commit to memory one or two facts relating to these measurements:—165 ft. cube is 165 ft. run of 12 in. $\times$ 12 in.; if we were dealing with a scantling of 12 in. $\times$ 4 in. its section is one

third of the 12 in. $\times$ 12 in., so that to make up a standard in that scantling we should want $165 \times 3 = 495$ ft. run for the 165 ft. cube. Knowing the price per standard, by ordinary arithmetic, a price per foot run of any required section is arrived at.

It is needless here to describe the process of seasoning and storing timber, as the reader will generally want only a small quantity, and will find that seasoned and ready for use in any well stocked timber yard. It is, however, useful to know that experiments show that felled wood, when green, contains about 45 per cent. of its weight in moisture. Timber felled in winter holds at the end of the following summer more than 40 per cent. of water. Wood kept for several years in a dry place retains from 15 to 20 per cent. of water. Wood that has been thoroughly kiln-dried will, when exposed to the air, under ordinary circumstances, absorb 5 per cent. of water in the first three days, and will continue to absorb until it reaches from 14 to 15 per cent., the amount fluctuating above or below this according to the state of the atmosphere. It will be evident from the above statements that wood, however dry, is still subject to change, and that even if kiln-dried, it requires to be stacked in a dry place until it settles to the natural conditions of seasoned wood.

Sound timber, kept constantly dry, will last for centuries; as examples, Westminster Hall roof, over 450 years old; dome of St. Mark's, Venice, 850 years old; basilica of St. Paul, Rome, some of the timbers were perfectly sound 1,000 years after being framed together. In situations where timber is alternately wet and dry, the most dense and resinous woods longest resist wet rot.

A little experience will show when a piece of board is seasoned; it is generally a little darkened or discoloured by exposure to the weather, dry to the feel, and light in weight,

as distinguished from a board newly-cut from the log, which is white and clean, clammy or damp to the touch, and very heavy as compared with the same wood when thoroughly dry. Warped or twisted wood would be quite unsuitable for cabinet work unless the twist was very slight. Indeed, such wood should never be used for any cabinet work, unless in parts where it will do no harm if it twists or warps, which it is very apt to do after it is finished and dries.

Shrinkage of planks and boards in seasoning:—

Teak	...	...	...	$\frac{1}{75}$	of the width.
White deal	...	...	...	$\frac{1}{70}$	„
Yellow pine	...	...	...	$\frac{1}{40}$	„
Northern pine	...	...	...	$\frac{1}{32}$	„
Oak	...	...	...	$\frac{1}{20}$	„

A cross grained board will easily be detected by examining its edge; see whether the grain runs parallel with the face of the board or slanting through the thickness. The face of the board also shows cross grain when the two halves of the board from the heart outwards have quite a different shade or colour, even when fresh from the saw mill. When planing such a board, one half has to be planed from the end to the centre with the grain, and the board reversed on the bench in order to plane the other half with the grain.

In veneering boards, it is always best to veneer on the side opposite the heart side, the reason being that veneer is apt to swell with the glue when being laid on, and, therefore, must contract after it is fixed. The heart side has always a decided tendency to curl, so the two forces counteract, and the wood remains flat. For this same reason it is always best to inlay on the outside.

It is often found that wood, which in the board or plank appears to be perfectly straight, will twist and wind in every conceivable manner when freed from restraint, on being cut

up into long narrow lengths, or cross cut into short broad panels. When wood is very badly twisted, it is technically termed "in winding." A tree may grow with wood in its upward direction having a spiral form not unlike a rope, and boards cut from such a tree are said to be of twisted growth, or cross in the grain, the grain running through the thickness of the board. In some pine trees this twist is so great as to make an entire circuit of the trunk from the ground to the lower branches.

The remedy for a board in winding is to plane off the high corners, and thus make it true by reducing the thickness. But if it be simply cast, that is with one side hollow and the other round, the defect may be got over easily if the defective pieces can stand by for a day or two. Then by placing the hollow side on a plane surface, or by putting two such boards one on top of the other, with the hollow sides facing, and piling weights upon them, the wood will be drawn straight without any more trouble.

When pressed for time, heat the round side on the stove. This makes the wood straight, but there is great risk of the wood opening and splitting under this toasting, and this liability is very much increased if the wood be at all shaky. The wood can be straightened, without this risk, by damping the hollow side with water, when the expansion of the fibre on that side pulls it straight. It is always best to work up the wood in its natural state: even if the tendency to cast be overcome previous to working it, there is always the probability of its returning. It sometimes happens that a piece of wood of some considerable width, such as a carcase end or a wardrobe panel, has to be reduced from $\frac{3}{4}$ in. to $\frac{1}{2}$ in. thickness. If this be all taken off one side, that side will become hollow, but if it be taken off equally from both sides the wood remains flat as before.

The following particulars include most of the principal woods that are used in cabinet work, named in the order in which they are of most importance, the first being American white pine (*Pinus strobus*); this timber is the ordinary "yellow pine," or "pine" of the joiner's shop; a very smooth, even-grained wood, free from knots. It is a North American tree, and grows in immense numbers in the region from Virginia to Canada. In the valleys and near the banks of rivers where the soil is rich and soft, the tree reaches its grandest proportions, growing often to a height of from 170 feet to 180 feet, and from 4 feet to 5 feet diameter at the base. The trunk of this tree tapers but slightly, and is entirely free from limbs or branches for over two-thirds of its length.

The principal ports of shipment are Quebec, Saguenay, Shediac, &c., and the usual market forms—logs averaging 14 in. square, but up to 26 in. may be had; deals 2 in. and 3 in. thick, and 9 in. up to 32 in. wide; qualities of deals are—"brights," "dry floated," and "floated."

Though we call this wood American yellow pine, it is called by the Americans themselves white pine, not so much from the colour of the wood as the colour of the bark. It is known also amongst us as Weymouth pine, from the fact of Lord Weymouth having, in the last century, planted large numbers of it in Wiltshire. The utility of the wood concerns us most. This pine was introduced into this country as an article of commerce early in the present century, and has now taken the place of Baltic timber, once used for the same purposes. It forms the groundwork of the bulk of modern furniture, that is veneered or otherwise made to assume the appearance of richer or costlier material. Besides this, from yellow pine alone innumerable articles of furniture are constructed; and, apart from its importance in cabinet work,

it is the favourite and most suitable wood in point of economy for all kinds of interior furnishing.

The Northern Pine (*Pinus sylvestris*) has the leaves growing in pairs; is also known as Red and Yellow Fir, also Scotch Fir and more generally in the trade as "red wood," or "yellow deal." It is grown in Norway, Sweden, Russia, and some parts of the Highlands of Scotland; the ports of shipment being Christiania, Drammen, Fredericstadt, Gothenburg, Gefle, Soderham, Stockholm, Sunderswall, Holmsund, Petersburg, Narva, Riga, Onega, Archangel, Memel, Dantzic, Stettin and Wyborg. This Northern Pine timber is exported in the form of baulks, planks, deals, battens, and prepared flooring, &c. The best baulks are those obtained from Dantzic and Riga; Christiania deals are considered the best. Archangel, Onega, Soderham and Gefle timber is good for general use, but, as a rule, the Swedish is not so much to be depended upon, and is very liable to twist and warp.

Memel timber has a scribe mark—either one, two, or three straight lines—to indicate respectively the first, second, and third qualities. Dantzic timber is marked near the centre of each baulk. Four qualities of Baltic Fir are shipped, viz. :—crown, best middling, good middling, and common middling. In addition to scribe marks, there are marks placed on the timber to denote the firm of shippers or the yard the timber came from.

White fir or spruce (*Abies excelsa*) has its leaves growing singly. It is more generally known as "white wood" or "white deal." This timber is not as strong or as durable as red wood; the tree has large loose knots, is soft and warps very much, and is very apt to break suddenly under a shock. It is grown in Northern Europe, in the same districts as the northern pine. The ports of shipment are principally in Norway and Sweden, also in Russia and Prussia. This

timber is mostly imported in the form of deals, battens and prepared flooring, matched boarding, and machine-made joiners' work. It is also largely used in the form of masts and spars, scaffold-poles, etc. In order to distinguish whether a lot of Baltic fir baulks are from Norway, Dantzic, or Riga, it is well to know that in Dantzic timber the quality is generally shown by a scribe mark about the centre of the baulk. For the best middling timber only one centre mark is used across a straight line. Russian timber is generally dry-stamped or hammer-branded at the ends. The best Dantzic timber runs up to 16 in. square, and 40 to 50 ft. long. Riga baulks are generally of smaller section, but are most to be depended on. Norway timber is generally stencilled with blue letters on ends, is smaller in section, and not so durable as either Dantzic or Riga. Few baulks are imported from Norway, but principally battens and prepared wood.

White spruce is very similar to the Baltic spruce, but is not as strong and is less durable, being also liable to warp and twist. It is also known as Canadian, or New Brunswick Spruce; the former is considered the better quality.

Pitch pine (*Pinus rigida*), is a heavy timber, full of resin, and fairly durable. All the pine woods contain turpentine, while the hard or leaf woods are free from this substance. Pitch pine baulks can be obtained up to 70 ft. long, but as the timber is subject to cup shakes and heart shakes, the larger baulks are not always reliable. It is grown along the Atlantic coast in America, the ports of shipment being Pensacola, Savannah and Darien, and the usual market forms—logs 11 to 18 in. square, and 20 to 45 ft. long; planks 10 in. $\times$ 3 in. up to 15 in. $\times$ 5 in. up to 45 ft. long; timber can sometimes be obtained up to 60 ft. long of straight, even grain throughout.

Yellow pine has for a number of years been principally supplied from St. John, New Brunswick, though much valuable

timber is shipped from other ports. Some is shipped in the form of squared logs, and is cut up into boards after reaching this country. Very much is imported in the form of deals, these being sawn, before embarkation, into battens of from 7 in. to 24 in. broad and 3 in. thick, and usually from 12 ft. to 20 ft. long. The quality of the timber is more easily discernible, and they are picked and classed as firsts, seconds, thirds, etc. They are converted at the mills into boards of the various thicknesses, to suit the requirements of trade, from $\frac{1}{8}$ in. upwards.

An examination of the interior of furniture made previously to the introduction of yellow pine will show the wood to be what we now call white or red pine, a wood full of resin and small hard knots. How much more pleasant is the task of the modern wood-worker with the clean, straight, soft, easily-wrought yellow pine than that of the workmen of sixty or seventy years ago, who had to contend against a hard, reedy, knotty, resinous wood, in narrow widths that required numerous joinings, and was ever twisting and shrinking. A large proportion of the wood of that period is called Memel, being shipped from a port in the Baltic of that name; it is to be noted that almost all woods imported into this country, whether American or European, are distinguished by the ports from which they are shipped.

Mahogany stands next, and, like yellow pine, it is used principally for internal fittings, and should not be exposed to the weather. There are two kinds, both well known, viz.:—Honduras, or Bay mahogany, which is imported from Central America; it is the best for strength and stiffness; it comes into our market principally in the form of logs and planks: and Cuba, or Spanish Mahogany, which is not as strong but has a much richer figure and is for this reason better suited for fancy work, and is capable of taking a very high polish.

Mahogany logs are sold by the foot superficial, 1 in. thick, and it is customary to allow at least 25 to 35 per cent. as *over-measure*.

Mahogany is suitable for almost all descriptions of work ; it is free from knots and less liable to warp than other woods. It is kept in stock at most wood-yards, and it can be obtained in pieces very long and wide and so the trouble of joining boards is seldom necessary. Mahogany does not decay. Sound mahogany never rots or suffers from moth-eat, like most home-grown woods, and if buried in the ground along with oak, walnut, ash, teak, etc., it will come out fresh after the others are decayed. Mahogany, which now seems indispensable to cabinet work, has only been in use a little over 150 years.

Before the introduction of mahogany, oak, ash, elm, walnut, and other home-grown woods were used in furniture making. After its introduction these fell almost entirely into disuse, and remained so for nearly a century and a half, everybody preferring the new and beautiful wood. Before then, oak was generally used instead, but it now seems to be declining. Formerly, bed-room furniture was generally mahogany ; now bedsteads are iron, and deal and birch are more used for the other articles, while for drawing-room furniture walnut is used as frequently as mahogany, and there is a tendency to return to oak for hall, dining-room, and library furniture. Mahogany, on the other hand, is more used in ship building, many boats and launches being built of this wood.

Spanish mahogany is grown in the island of St. Domingo or Hayti ; its characteristics are hard and close grain, with a rich and beautifully-mottled figure, varying in colour from gold to ruby, and it takes a splendid polish. There is a great variety in this figure or mottle. Light and dark streaks running with the grain, and in unbroken lines, is considered plain wood.

If the light and dark shades are broken up and run across the grain in small patches, the wood is of a good figure. Curls have the grain or dark and light shades running slantingly away from the centre, just as the water is divided by the rapid passage of a boat. The curls are cut from a forked part of the tree. This mottle may be often seen in panels, when the grain or figure always runs outwards or downwards. It is very beautiful, but is not highly valued, as it is apt to crack when used as a veneer.

Stop mottle has the light and dark figure produced by a regular grain running out and in like little waves, not regularly across the plank, but broken up and running into each other, which gives a beautiful transparent lustre, much prized in this wood. Fiddle mottle has the waves running across the plank in almost regular lines, like maple used for violin backs.

Peacock mottle is so called from having small eyes like bird's-eye maple, and like the spots in a peacock's tail; it is very rare, and a well-marked log of this mottle will bring an almost fabulous price.

Cuba mahogany is imported from the island of Cuba. In closeness of grain and in figure it is generally inferior to Spanish, and though some of it is rich in figure, it has not the lustre of good Spanish, and on exposure to the atmosphere and the sun it becomes pale and lacks lustre. It is extensively used as veneer for large surfaces, such as wardrobes, large panels, and sideboard tops, where rich Spanish wood would be too costly and perhaps too finely figured. Cuba wood is much used for the solid parts of furniture, such as bed-posts, turned work, carved pillars, trusses, etc., and is superior to Honduras for most of these purposes.

Honduras or Bay mahogany is frequently called bay wood, and is principally used for structural work, to be veneered upon, and is the best wood for this purpose; it is free and

straight in the grain, when seasoned it does not warp or shrink, and holds the glue admirably. It is sometimes cut into veneers for ends and inferior parts of cheap furniture, but its principal use to the cabinet worker is in constructing the framework for doors and other exposed parts to be veneered on the outer face. Panels also are of bay mahogany, veneered on the face; the backs of panel and framing are French polished, and being of the same colour as the richer wood on the face, the whole harmonises in appearance. Bay wood, from its freedom from warping or shrinkage, is valuable for many purposes besides cabinet work.

Walnut wood is commonly classed as of three kinds, namely, English, Italian, and American; but more properly as two: the Italian may be taken to include all European walnut. Italian walnut was a favourite wood for rich furniture in ancient times, and has continued to be so, except in the period when mahogany was the rage. This walnut is very light and is easily worked, being rather soft and spongy. It is largely used for gun-stocks, from its lightness and toughness. In appearance the plainer wood is a dull grey, with darker streaks, sometimes waved across the grain, like fiddle maple. Much of it, however, is simply streaked dark and light, lengthways of the grain. American black walnut is now imported largely; it is inferior to European. It was at first used largely for the ground work of furniture, to be veneered with rich Italian wood, just as Bay wood is used as a backing to Spanish veneer. Now a quantity of furniture is made from it without any veneer whatever, and while it, in common with all the walnuts, is destitute of that lustre and transparency which characterise mahogany, yet it is a good wood for furniture. It is the wood chiefly used for sewing-machine stands, is largely used in making harmonium cases, and in furniture it ebonises well, and makes a good contrast when

used along with ash, satin, or bird's-eye maple. It is also very elegant when relieved by gold lines.

Of oak there are but three leading varieties in general use : English, Baltic, and the American white oak, though botanists enumerate about 150 different species of oak. Oak has been used as a furniture wood from all time, being found in almost every country on the globe.

In England it was almost the only wood used for furniture by those who had any. Though it is a coarse-grained, porous wood, destitute of lustre, it has a beauty of its own, when the figure is well marked ; but its preference seems to consist in its association with our ecclesiastical and maritime institutions. Oak furniture gave way to walnut, and later on to mahogany, but is still largely made.

English oak (*Quercus pedunculata*) is a very durable timber, tough and dense, with very strongly marked medullary rays, which are called "silver grain." The cluster-fruited or bay oak is another English variety, in which the grain is more uniform and darker, and the medullary rays are not so strongly marked as in the other species. The market forms are logs and planks.

The oak now generally used is not British, but comes from Northern Europe, being shipped from Memel and Dantzic, in the Baltic. This oak, being easier worked and the rays much more distinct and in strong contrast to the ground wood, is better suited for furniture and interior finishing. The best specimens of this oak are shipped from the port of Riga, and fetch the highest prices. The market forms are logs and planks. This timber is straight in the grain, free from knots, but not as durable as the English wood.

American white oak is imported in the form of logs and planks. It is tough and very elastic, though not as durable as the English wood, but in some respects superior to the Baltic timber.

A quantity is shipped from Quebec ; this is a coarse, reedy oak, not so good for ship-building as English, and not so good for furniture as Dantzic or Riga. When not twisted in the growth it may be split evenly into thin pieces, and a large quantity is imported thus split for the use of coopers. It is also used for numerous other purposes, and occasionally in cheap furniture. In all oak there are thin veins, called medullary rays, that run from the pith to the bark, something like the spokes of a wheel. In the end of a billet of oak they appear like hard white threads radiating from the centre, and as they run the whole length of the tree, it is by judicious cutting up that their "champs" or rays are best shown. This is the principal feature of beauty which commends it in furniture. Very much depends on the intelligent cutting up of oak, as well as many other woods. Timbers with strong medullary rays should be cut up so as to avoid having the rays running across the thickness of the stuff.

There are various kinds of birch, but the black birch of America is that most in use for cabinet work. It has been extensively used for bedroom and kitchen furniture. It is of a whitish-brown colour, and harder to work than bay mahogany. Very much of it is beautifully figured by waves going across the grain like in fiddle maple, but generally the waves are larger. The curled specimens are very beautiful. The most richly-figured is called mahogany birch or mountain mahogany, from the resemblance to Spanish mahogany. Indeed birch is often coloured to represent mahogany, though this species of birch never looks better than in its own natural tint, which is a golden transparent yellow, and if the figure is small it is sometimes difficult to tell it from the finest satin-wood. The richly-curved pieces are generally cut into veneers. The plain black birch is used almost entirely for kitchen-chairs and other plain hard-wood furniture.

CHAPTER II.

BENCHES AND APPLIANCES.

TOOLS used by the cabinet worker naturally require consideration after something has been said about materials. In this chapter benches and appliances will be treated upon, and other tools in the following three chapters. A volume in this series : *THE PATTERN-MAKER'S HANDYBOOK*, contains much information on the subjects of this chapter, some of which is reproduced here, and also a few illustrations from the same source.

A bench of some kind is necessary for the cabinet worker ; and in travelling from shop to shop and in different countries, all sorts and all conditions of benches are met with, and at which he is expected to feel at home. In some shops the benches are made with a wide board on edge in front, to support the top, leaving a space of about 18 inches between the floor and the under edge of this board. One never knows what has been stowed away underneath this kind of bench ; nor the treasures they cover out of sight, to be turned out by posterity, or perhaps to remain for all time. The same sort of bench, if made a foot or so wider, may have two men working at diagonal corners. It becomes social, and rare old yarns are told across these big benches. On a double bench, tools, especially when good and sharp, have a knack of travelling to the other man's corner, and his idea of the extent of his half of the top may sometimes include about seven-eighths of the whole. Always be it noted that it is never the other man's tools that travel towards our side, unless they want sharpening ;

and it is never we who claim more than a fair half of the bench!

The bench first illustrated, see page 19, will commend itself to amateurs and others who have but limited shop-room. It is a bench and tool chest combined, and Fig. 1 will give a fair idea of the appearance of this bench. On looking at sketch, you will see, below the bench top is all enclosed, and on the front two doors, with an upright post between. Over the right door is a drawer, and over the other a space, between the rail and the bench top. The space enclosed by the two doors, together with the drawer, meet the requirements of a tool chest. Saws may be hung along the back, horizontally, on racks. Planes will lie on the bottom, and it is very handy to have a few shallow boxes for holding small tools. These boxes will pile one above the other, thus taking up little room. To make this bench requires a considerable acquaintance with the use of the tools, and the following description is intended for those who have had some practice. Those who are unfamiliar with the use of tools would do well to secure assistance in making, or perhaps, get the bench made to order by a joiner. If the wood used is good and clean it may be varnished white, a few black lines on the doors and drawer add to the appearance; or it may be stained or painted, excepting the top and the inner face of the vice-jaw, any desired colour. A bench made in this way makes a neat and useful sideboard when not in use as a cabinet worker's bench, as the lug may then be removed.

The following particulars and dimensions will enable anyone able to handle wood-working tools to construct a bench as represented on page 19. The top is of yellow pine, 4 ft. long, 22 in. broad, and 2 in. thick, which should be free from shakes, though a knot or two will not spoil it. The frame is also of yellow pine; it is made 3 in. shorter than the top, which

therefore overlaps $1\frac{1}{2}$ in. at each end; and 30 in. high, so that with the top added the bench is 32 in. high. The two back legs and the right front one are 2 in. square. The left front leg where the vice is attached is 4 in. by 2 in. These legs are framed together with rails, 2 in. by $1\frac{1}{2}$ in., a fore leg and a back leg having two rails, framed up by mortise and

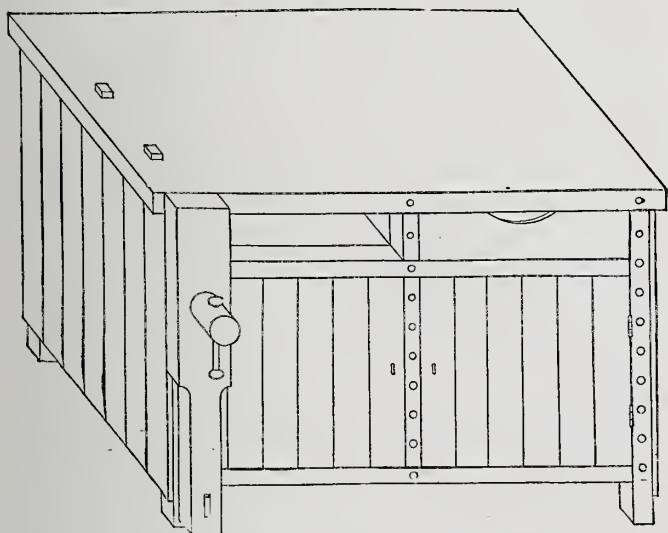


Fig. 1.—COMBINED BENCH AND TOOL CHEST.

tenon, one at the top, and another 4 in. from the ground. These rails are put in flush with the outer face of the legs, as they form the framing for a covering or lining; this forms the two ends of the frame. The four long rails, back and front, are let into the legs by mortise and tenon: two rails $4\frac{1}{2}$ in. from the top, and the other two on a level with the end rails, 4 in. from the floor. A bottom is now made, 3 ft. 9 in. long, of $\frac{5}{8}$ -in. boards to rest upon the back, front, and both end rails, covering the entire area of this frame, the corners being cut

out for the legs. When this bottom is fitted in and nailed to these four rails, the two ends and the back of the frame are boarded with $\frac{1}{2}$ -in. lining, in widths of about 3 in., the joints running vertical. This lining fits close up to the under side of the bench top, but need not go lower than about 3 in. off the floor. The top is fixed by screws passing upwards through the two end rails, and in front must be kept flush with the frame. At the ends it will project about 1 in. over the $\frac{1}{2}$ -in. boarding nailed to the framing. The drawer shown on the right is supported by guides running from front to back of the frame; they should be put in when the frame is being put together, and the drawer must be fitted before the top is fixed down. The drawer is $4\frac{1}{2}$ in. deep on the face, and it is made long enough to reach to the back lining. It is partitioned inside for holding small tools. Instead of a handle, which would catch in the workman's clothes, the upper face of the drawer is cut away in the centre. This admits the hand to pull out the drawer.

The vice for this bench is oak, beech, or birch, 5 in. broad, $1\frac{3}{4}$ in. thick, and it reaches from the top to within an inch of the floor; 9 in. from the top the screw passes through it and the bench leg. This screw is like that shown at Fig. 3, but it may be of iron, square threaded, and 1 in. diameter; either may be bought in any tool shop. The nut is fastened to the bench leg behind. At the lower end of the jaw is a piece of wood called the "sword;" this is 2 in. broad and $1\frac{1}{2}$ in. thick; it is fixed into the jaw, and passes loosely through a mortise in the bench leg; a number of $\frac{1}{4}$ -in. holes are bored through this sword, and a short iron pin is inserted through any of them in front of the bench leg and thus the jaw is kept parallel with the leg when work is being held in it. If the screw and the sword are each about 12 in. long the vice will open to take in work up to 9 in., which is sufficient for almost any

purpose. The lower portion of this jaw is cut away for about half its length to 3 in. in breadth, as shown in the drawing. Two "stops" are fitted in the top of this bench; they are small square pieces of hard wood projecting upwards. Most benches have but one stop; two are much more handy for various things. As shown in the illustration, one stop is placed about 4 in. from the front, and about the same distance from the end; the other is in line with the first and about 6 in. farther back. In planing short and broad pieces, these two stops prevent the piece slipping off the bench; for although this does not often happen with an expert, it is very apt to do so with a beginner having but one stop on his bench. The hard-wood forming these stops must be parallel, and the holes made to let them pass through the top neatly and somewhat tightly; they are 5 in. long, and are struck upwards with a hammer from underneath the bench. Other stops are made to fit the same holes; one has a piece of iron or steel screwed to its upper end, with a row of sharp teeth on one of its edges. Work, such as a rail to be moulded, being thrust against these spikes is held firmly from slipping. This form of stop is much tidier than nails driven into the bench to effect the same purpose.

The upright post between the doors has a number of $\frac{5}{8}$ -in. holes bored through it; the right corner leg is also bored in the same way. An oak or ash turned pin, having a head to it, fits these holes; it is used to rest the lower edge of a board upon when fixed in the vice for the purpose of planing the upper edge. The pin is placed in the hole at a suitable height to keep the board horizontal. For short work the middle row of holes is used, and for longer work the end row. When not in use, this pin should be kept in some place where it will not get lost. The space shown to the left of the drawer is intended for receiving the end of pieces of board, which rest

upon the rail. The left hand pressing down the outer end, the inner one is pressed up against the bench top, and any piece of board is thus held while being sawn.

The bench that will be next described is suited to the small workshop. The top is in two pieces, and is 6 ft. long and 2 ft. broad, and Fig. 2 shows the complete bench. The front portion of the top is 15 in. broad and $2\frac{1}{2}$ in. thick, of red or yellow pine, free from shakes and twist; the back piece is 9 in.

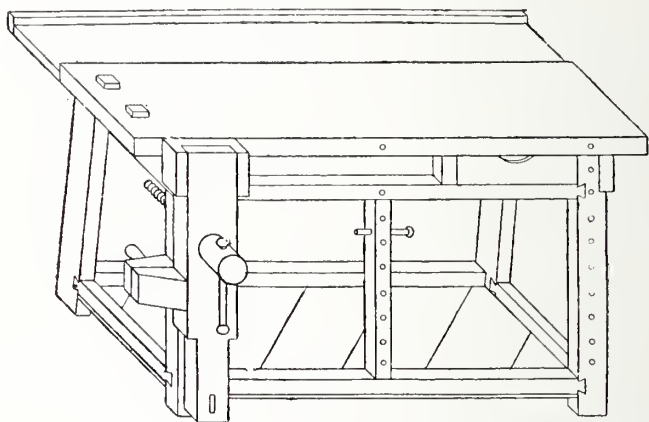


Fig. 2.—HOME-MADE BENCH.

broad and $1\frac{1}{2}$ in. thick. Both rest on level rails, which make the back piece 1 in. lower than the front, and along the back edge is screwed a strip 1 in. thick, which brings it level with the front, so that broad work will rest solidly across the bench. The object of having the back portion of this bench an inch lower than the front is so that nails and small tools and chips may lie in the sunk part without interfering with work on the bench. The strip at the back prevents tools rolling off the bench, which they often do, and become lost on the floor amongst shavings. The frame of this bench consists of two

rails screwed to the legs, as in the sketch, Fig. 2. These rails are 5 in. deep and 2 in. thick.

Three of the legs are 4 in. by 2 in., and the fourth, that behind the "lug," or vice, is 6 in. by 2 in., all of good red pine. The back legs slant forwards at the top, the ends of the rails being rounded off. The lower rails are 3 in. by 2 in., and 4 in. from the floor. The three long rails are fitted to make the frame measure 5 ft. The back and front rails are 3 in. from the floor, and one in front, 4 in. below the top. They are dovetailed into the legs, and fastened with large screws, so that the bench may be taken to pieces for removal. Under the lower rails a boarding is nailed for holding some of the larger tools, and a small drawer is often put at the top right side, as shown in the sketch, to hold some of the smaller tools.

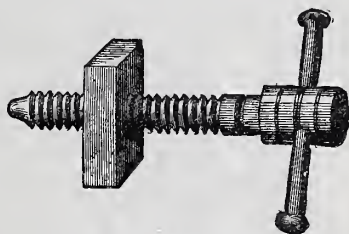


Fig. 3.—BENCH SCREW.

An upright post is fitted in the front of this bench between the two rails. It has holes for a pin, as has also the right leg. A hole bored through the post at right angles to the others is to keep this pin in when not in use, as shown in the figure.

The lug of this bench should be of clean, straight, hard-wood, 7 in. broad, cut away at the bottom to 4 in., and 2 in. thick. The sword is $2\frac{1}{2}$ in. broad, and $\frac{5}{8}$ in. thick. Sometimes the lug has a piece of hard-wood screwed across its inner face at the upper end; this piece should be 10 in. long, 6 in. broad, and $1\frac{1}{4}$ in. thick. The bench here shown is so fitted. For some purposes this is an advantage.

The screw, shown at Fig. 3 is the kind to be used for the lug of this bench; they may be bought at the tool shops with

the nut fitted. In addition, there is a side screw, which is found of advantage, as explained next.

A piece of wood is mortised into the edge of the "lug," and a similar piece into the edge of the leg, shown in Fig. 2—they project outwards 6 in. A short wood screw works through the back-piece, and its point presses against the piece projecting from the lug. The ordinary lug cants over when the end of a broad board is fixed in it, and the pressure is all

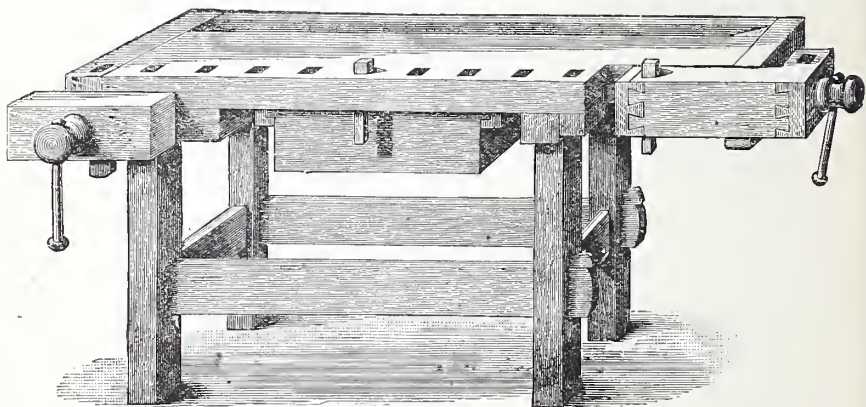


Fig. 4.—GERMAN BENCH.

on the edge of the board, which is very damaging to a piece of finished work. This side screw cures this, as it is turned out or in to suit the thickness of the work in the lug, the sword at the bottom being regulated by a pin.

Fig. 4 shows a bench made and used on the Continent, and now often met with here, it being imported complete, and sold at the tool shops. This German bench is particularly useful for general wood-working, as it has a multiplicity of devices for holding work under operation.

For general purposes, a good stop is simply a square piece of hard wood, fitting tightly in a mortise in the bench-top. It

is suitable for the kind of bench shown in Fig. 1, and the stops put in this bench come through outside of the front rail, as shown. For a bench that has a deep front board, some modification is necessary to save going down on one's knees to knock up the stop. For general service a wooden stop is the best. It does not cut into or damage the work so much as an iron one. If a plane or other tool comes in contact with a wooden stop it will not destroy the edge of that tool.

It is well for some purposes to have an iron stop let into the bench. When not in use it sinks level with the top of the bench, so that it is quite out of the way of tools and work. The special advantages claimed for an iron stop over a wooden one are: the teeth of the iron stop (see Fig. 5), entering the wood, resist any tendency to slip to a much greater extent; and in planing thin stuff the iron stop is better, because the wooden stop, when worn, or when the stuff is not lying perfectly straight upon the bench, allows the thin board to rise and pass over it when the force of the plane is applied.

The holdfast, or valet, is made of iron, and is used to hold work firmly on the bench to be mortised, or otherwise operated upon. Fig. 6 shows one which consists of an iron rod, $1\frac{1}{4}$ in. diameter, with a piece bent and forked to take a lever arm, fitted on a pin between the fork. The short end of the lever has a square-threaded screw passing through, with its end in contact with the end of the rod. In using the holdfast, the bar is dropped through a hole in the bench-top, the curved end of the lever coming down upon the work to be held. Pressure is applied by turning the screw at the short end of this lever, and by these means the work is securely held.

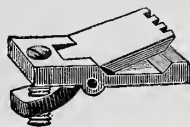


Fig. 5.
IRON BENCH STOP.

A small vice is very useful for holding small work to be sawn with the bow-saw, as this tool can be got round such work

much better than when it is fixed in the lug itself; the

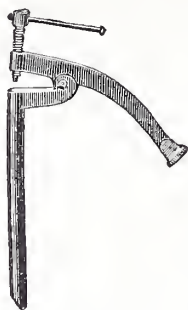


Fig. 6.—HOLDFAST, OR BENCH CRAMP.

operator can also stand erect. It is also useful for holding all kinds of small work to be operated upon with the chisel, file, spokeshave, or other tools, as well as for holding the smaller saws to be sharpened. Fig. 7 shows a handy home-made vice of this description. It is made of beech or black birch, and has two sides, or jaws, 13 in. long, 5 in. broad at the upper part, 3 in. at the lower, and $1\frac{1}{2}$ in. thick. Through these

jaws, 5 in. from the top, a wooden screw passes, $1\frac{1}{2}$ in. diameter, and 9 in. long on the screwed part. This screw is shown at Fig. 3, it goes freely through the front jaw, but is tapped into the other. Near the bottom is a screw $\frac{5}{8}$ in. diameter, tapped in the front jaw, and pressing against the other; its use is to keep the jaws parallel, in the same way that the sword does the bench lug. Projecting from the edge of the back jaw is a piece, 6 in. long and 4 in. broad; by this the vice is held in the bench lug. A small fillet is screwed to the back of the back jaw, which, resting upon the bench, prevents the vice slipping downwards when using it. The screw-head has a wooden lever pin, 9 in. long and $\frac{3}{4}$ in. in diameter, passing through it.

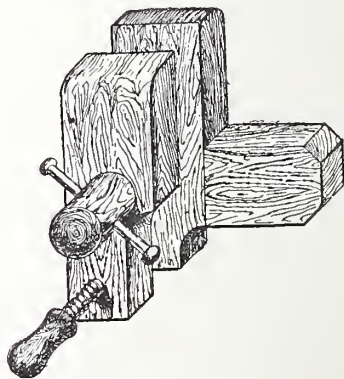


Fig. 7.—SMALL BENCH VICE.

A hand-screw is shown, Fig. 8. It consists of two jaws

and two screws. There are several sizes, and in a well-appointed shop generally several pairs of each size. The large size has jaws about 20 in. long, 3 in. broad and $2\frac{1}{2}$ in. thick, with $1\frac{1}{4}$ in. screws about the length of the jaws. The second size has jaws 14 in. long, and screws in proportion. The third size has jaws 12 in. long, 2 in. broad, and $1\frac{1}{2}$ in. thick. The screws are $\frac{3}{4}$ in. in diameter, and have the screwed part 9 in. long. The small size has jaws $7\frac{1}{2}$ in. long, $1\frac{5}{8}$ in. broad, and 1 in. thick. The screws are $\frac{1}{2}$ in. in diameter, and have 8 in. screwed.

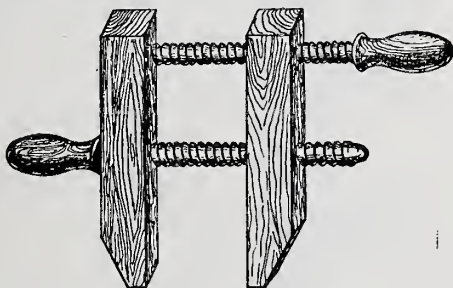


Fig. 8.—HAND SCREWS.

Hand-screws have the two jaws planed parallel, and tapered off at the end on the outside. In the middle of the length of one jaw a hole is bored to allow the screw to pass through freely. In the other jaw, a hole is made and tapped for the screw, and at the end a second hole is tapped for the second screw. In the first jaw, and opposite the point of the back pin, a shallow hollow is made. This is to prevent the point of the screw slipping when the hand-screw is being fixed upon the work. To open these screws speedily to the required width, take the head of the middle pin in your left hand, and the head of the other in your right, and by twirling them one way the jaws are opened, and by twirling them the other way they are as rapidly closed. The screws should be blacklead, and they then work easily in the threads. These screws can be cut with the screw-box shown at Fig. 33, and the holes tapped with the tap shown on the same page.

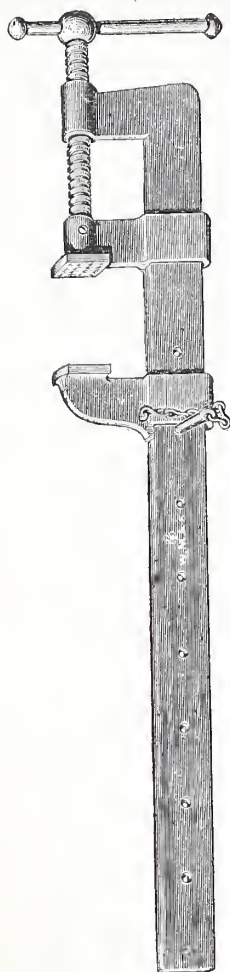


Fig. 9.

LIGHT IRON CRAMP.

Among indispensable tools is the cramp, made wholly of iron, and shown at Fig. 9. A useful cramp is one that will take in 3 ft. This should have a lengthening bar, which will enable it to take in another 3 ft. The lengthening bar is attached with two short bolts and nuts. Cramps are often used in pairs, and with the cramp just described, and a pair to take in 30 in., and another pair to take in 20 in., and an assortment of hand-screws, a workshop might be considered furnished with cramps.

The shooting board lies upon the bench and against the stop. Its use is for squaring the ends of short pieces of stuff, the plane being laid upon its side and pushed forward. Fig. 10 shows a shooting and mitre board combined; when used as a mitre board the plane is pushed in the same way, but the wood is planed to an angle of 45° . This board is used for mitring all mouldings of a thin, flat description. It is also used for small frame mouldings of all kinds. The use of a shooting board for jointing the ends is a common practice, but the joint is made more quickly and is stronger when made with a saw, which does not close the pores of the wood as a plane does when cutting at an angle with the

grain; and the short grain on the corners is not so liable to break.

The shooting board shown at Fig. 10 is made of two pieces of Bay mahogany, each 30 in. long, 6 in. broad and 1 in. thick. One overlaps the other 2 in., and they are screwed

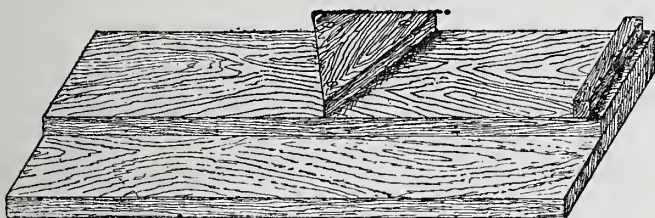


Fig. 10.—SHOOTING AND MITRE BOARD.

together, thus forming a lower bed, 4 in. broad, where the plane runs, and an upper bed 6 in. broad. The under-side of the board must be made up at the ends by two fillets 4 in.

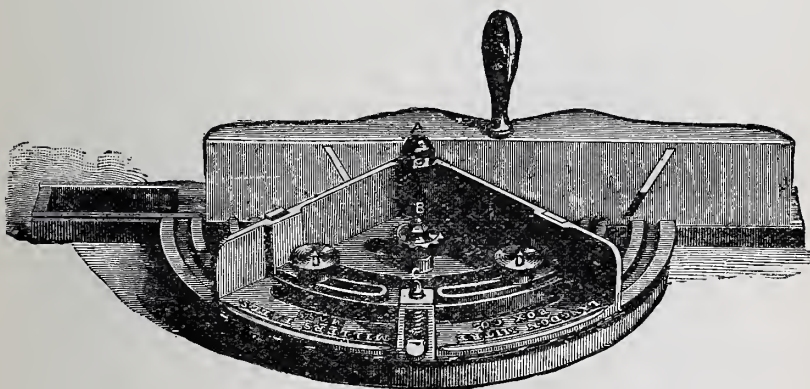


Fig. 11.—ADJUSTABLE MITRE PLANER.

long, 2 in. broad, and 1 in. thick, screwed on, which gives a level bearing surface 10 in. broad. A fillet, or stop, of mahogany is made, and sunk into a shallow groove an inch

from the fore end, and at exactly right angles with the edge or shooting direction of the plane. A triangular piece is made, having two adjacent edges at right angles, and it must be placed upon the board about the middle of the length, with the right-angle corner pointing towards the sole of the plane, and the two edges exactly at an angle of 45° with the sole of the plane. It should be sunk into the board about $\frac{1}{8}$ in., and fixed with screws. It has occasionally to be taken off, to admit using the whole length of the board as a shooting board.

An American mitre planer is shown at Fig. 11. It is made entirely of iron, and will plane any desired angle on straight or curved work. The bed piece is semicircular, with guides in which the plane runs. The movable quadrant has its sides at right angles; these act as guides for the material to be planed; it turns on the stud A, and can be placed at any angle. When in the centre, a mitre joint is planed. The adjustable guides, which are fixed by the screws D D, are used when pieces of oval or circular form are to be planed accurately to gauge.



Fig. 12.
BOOTH'S MITRE CUTTER.

Fig. 12 shows a very handy mitre cutter, which slices off the wood at an angle of 45° . For picture and other frames this works very quickly. Mitres are cut sloping in either direction in this same tool.

A circular saw is much quicker in its action than a hand saw, and when much sawing has to be done such a machine as is shown at Fig. 13 is very useful. It has been recently brought out by the Britannia Company, and is a patented machine worked by a treadle. The capacity of the machine

is four inches thick ; it runs one thousand five hundred revolutions per minute, has adjustable mitre and cross-cut gauges,

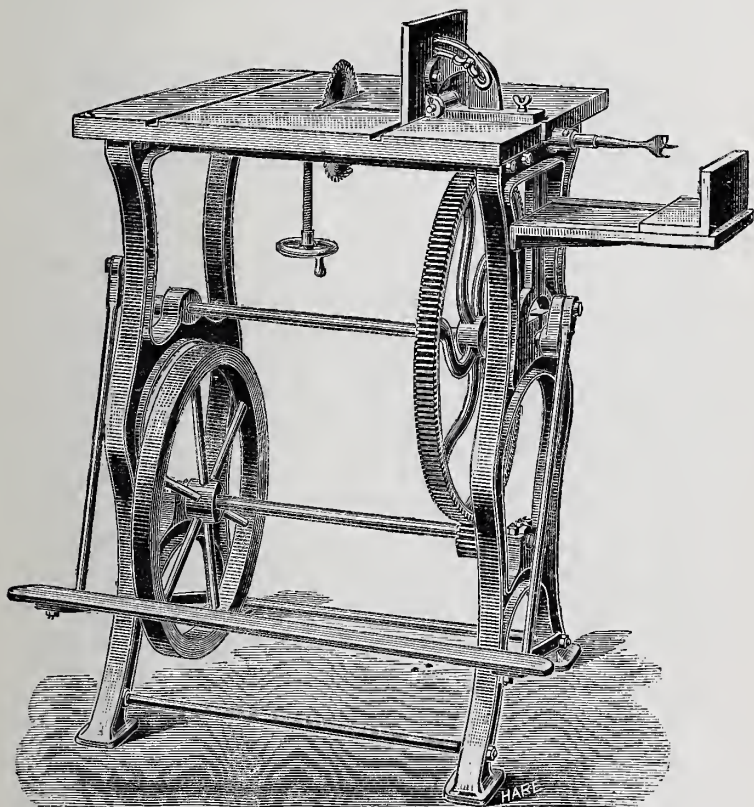


Fig. 13.—CIRCULAR SAW FOR FOOT POWER.

boring attachment, &c. Wood an inch thick can be sawn at the rate of 10 ft. per minute.

CHAPTER III.

MISCELLANEOUS TOOLS.

N the succeeding chapters tools of distinctive character are grouped under the headings of "Planes" and "Boring Tools;" but before we come to those it is well to make the acquaintance of other useful tools which are not included in either of the above headings.

Probably the first tool that will be required when practical work is undertaken will be a rule for measuring. The ordinary form of jointed 2 ft. rule is shown at Fig. 14, and this is the most convenient for general use. Each fold is a foot long, so that when open the rule measures 2 ft. There are many varieties in the qualities of these rules sold at the tool shops. So far as actual measuring is concerned, probably the medium quality are as good as the best, because the cabinet worker usually measures only approximately, and when any great nicety is required it is a question of fitting one piece to another rather than of making to an accurate standard measure.

The cheap rules, and 2 ft. two-fold ones, made to sell for a few pence, are objectionable chiefly from being badly jointed. The cheapest joint is called a round joint, and the metal is let into saw-kerfs in the wood and does not show on the side of the rule. The joint shown at Figs. 14 and 15 is called an arch joint, and is the best; an intermediate joint has the plate cut square across, and much shorter than in the illustrations. The name shown on these figures, it may be noted, is a guarantee that the rule bearing it is a good one.

For carrying in the pocket, and for some other purposes,

the four-fold rule shown at Fig. 15 is more convenient than the two-fold. A rule-pocket, in the seam of the trousers from the hip to the knee, will, however, take a foot rule without any inconvenience.

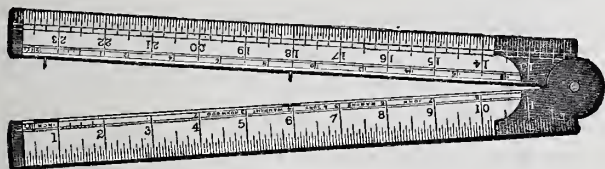


Fig. 14.—TWO-FEET TWO-FOLD RULE.

In conjunction with the rule a black-lead pencil is commonly used for marking. Special pencils are made for this purpose; they are much larger than draughtsman's pencils. For marking fine lines on work that is nearly finished, and which a black pencil line would mar, and perhaps would not be fine enough, a marking awl, as shown at Fig. 16, is used.

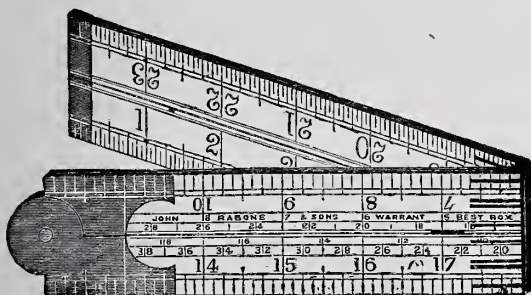


Fig. 15.—TWO-FEET FOUR-FOLD RULE.

This is a useful tool for marking mitre joints, dovetails, and all other purposes when marking is required to be accurate. The round end is used for marking, and the chisel end is for actually cutting the wood on the exact line required, so as to give a positive guide for the saw or other cutting tool that is

to follow. The marking awl is generally used with the square, next illustrated, or some similar tool, as a guide.

The square, as shown at Fig. 17, has the stock made of wood, with a steel blade set at right angles, both handle and



Fig. 16.—MARKING AWL AND CHISEL.

blade being straight-edges. Squares are made as large as 12-in. steel bladed, and wooden ones up to 3 ft. in length. Their use is to set out work at right angles to a straight edge. The bevel is a somewhat similar tool, but the blade is adjustable to any angle. The mitre bevel resembles both the square and the bevel; its blade being fixed at an angle of 45° to the stock. Usually the steel blades are about $\frac{1}{16}$ in.



Fig. 17.—PLATED SQUARE.

thick, and the stock $\frac{5}{8}$ in., both being about 2 in. broad. The mitre bevel is useful for marking off, at an angle of 45° , pieces to be mitred together.

Saws are most important wood-working tools, as these are used in the first conversion of timber. Ordinary wood

workers have some six or eight saws, but for cabinet work a few suffice.

The rip saw is used for cutting wood with the grain. The blade is 28 in. long. It has three teeth to the inch, which are filed square across the blade, and are set raking very much forward.

The cross-cut saw is 26 in. long in the blade, and has four teeth to the inch, which are filed at an angle of about 60° with the blade. The teeth are "set" to clear the draught in sawing, so that they do not bind in the kerf. This set consists in every alternate tooth being bent sideways one way, the remaining teeth being bent to an equal degree the other way. Saw-makers set their saws by striking the alternate teeth with a hammer on a smooth anvil, to give a proper inclination; then turning the saw over, the untouched teeth are bent in the opposite direction. This is the best mode of setting a saw; but generally it is done by bending the alternate teeth in contrary directions with a slotted steel plate. Several contrivances have been brought forward under the name of patent saw-sets, by means of which the amount of bend

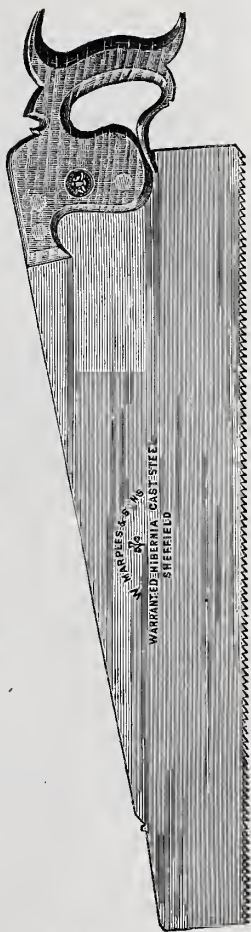


Fig. 18.—HAND SAW.

given to each tooth becomes an invariable quantity. Every alternate notch is filed with the file pointing at an angle of 60° with the blade, and the intermediate notches are filed

with the file pointing to the opposite corresponding angle. The outer corner of each tooth is thus brought up to an acute point; and looking along a properly-set saw, an angular furrow is shown along the teeth. A needle placed between the first teeth, will run from end to end on tilting the saw.

The hand saw shown at Fig. 18 is similar to the above, but has finer teeth. It is an excellent saw for general purposes, either light ripping or cross-cutting; and we may usually dispense with the other two described above—they being used only for heavy sawing.



Fig. 19.—IRON-BACK TENON SAW.

When using a hand saw, care must be taken to “keep the draught”—that is, keep the saw kerf on the pencil line, and also to saw square through the thickness of the board. A beginner is apt to give the saw a curved instead of a straight up and down motion, the handle of the saw inclining towards him; consequently the draught gets off the square. It is usual to take the square and apply the stock to the board, and the blade against the saw, which shows at once if sawing straight.

Back saws have a thin blade, from about 6 to 18 in. long, with a brass or iron back to stiffen them. The tenon, or sash, saw, Fig. 19, has a closed handle. It is used for sawing both with the grain and across, and particularly for cutting tenons.

The dovetail saw, Fig. 20, is used for cutting dovetails, as its name implies, and for an infinity of small work besides.

It has a very thin blade, from 6 to 10 in. long, very fine teeth, a brass or iron back, and an open handle.

The turning saw is useful for all kinds of small curved sawing. It consists of a frame made of beech or rosewood as shown at Fig. 21; the two ends are held apart by a stretcher let into them by a short tenon, near the middle of their length; through the lower ends, the handles are inserted, having brass rods riveted through them; the inner ends of the rods are slit to receive the saw-blade. A strong cord is wound round the opposite ends of the frame, and by means of a short wooden lever the cord is tightened by twisting, which pulls apart the lower ends and tightens the saw-blade. Both handles carrying the blade turn



Fig. 20.—DOVETAIL SAW.

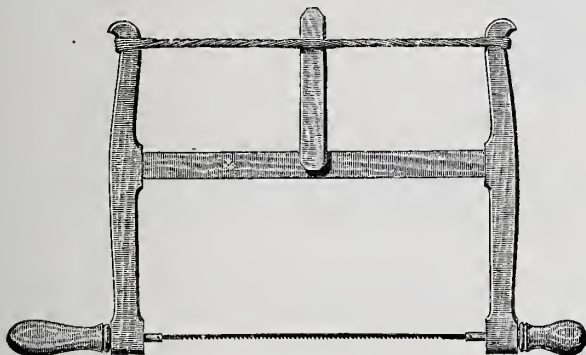


Fig. 21.—TURNING FRAME SAW.

in the holes, and thus facilitate getting round curves. In using this saw, the work is held in the bench vice and the saw is held by one handle.

The keyhole saw consists of a handle about 9 in. long. It is pierced with a narrow slit from end to end, and receives the blade. This is very narrow at the point, it has about five teeth

to the inch, and may be shortened or lengthened at pleasure, and fixed at any desired length by two binding screws in the ferule. This saw is handy where the turning saw cannot be used.

The axe, or hatchet, is a tool not much used in cabinet-making, but it serves to roughly shape a mass of wood. If a piece of wood is to be turned the axe is used to cut off the angles, and it may also be used to reduce to a certain form a block of wood that is to be carved. Axes are sold by weight; a small one only is required, and, indeed, this may be

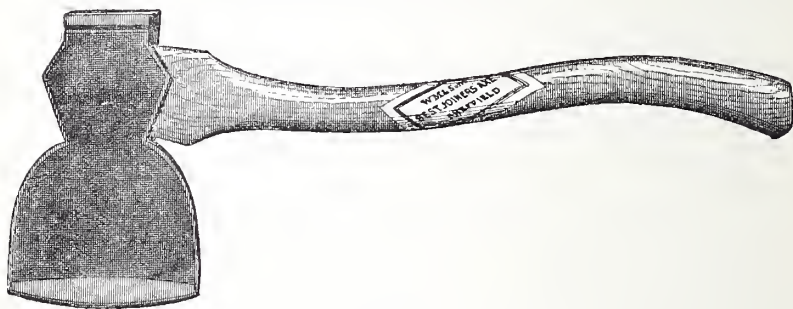


Fig. 22.—KENT HATCHET WITH BENT SHAFT.

dispensed with. A good shape is that shown at Fig. 22; all that the axe is used for may be accomplished with a large chisel and mallet.

The draw-knife, the ordinary form of which is shown at Fig. 23, is a tool almost equal to the axe for making chips, in shaping work. A draw-knife is shown in Fig. 24 having both its handles adjustable. On the right hand is shown the method of attaching the handles. By slacking the nut the handles may be drawn back and adjusted to any angle. Teeth in the handle engage with teeth on the shank of the knife, so that when the nut is again tightened the handle is fixed in its new position. This improved draw-knife can be got to work in places inaccessible to the ordinary tool.

The spokeshave is a tool coming between the draw-knife and the plane ; it has its blade in the centre, and a handle at each end. Fig. 25 shows the ordinary form which is used for shaving narrow surfaces where perfect evenness is not essen-



Fig. 23.—ORDINARY DRAW-KNIFE.

tial. Iron spokeshaves are far ahead of the old wooden spokeshave, with its cutting-iron like a square staple, the horns of which prevent its being ground upon a grind-stone. An iron spokeshave can be sharpened as easily as a plane, and is adjustable to suit different curvatures.

Chisels are the chief paring tools used by the cabinet

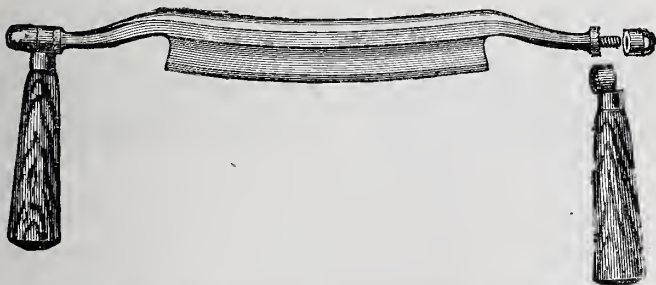


Fig. 24.—DRAW-KNIFE WITH ADJUSTABLE HANDLES.

worker ; they are of three kinds—firmer chisels, paring chisels, and mortising chisels. Firmer chisels, shown at Fig. 26 are the ones most generally in use, from $\frac{1}{4}$ in. to 2 in. wide, and are employed for trimming off, removing superfluous wood, and

sometimes making mortises in thin and soft wood, though this latter purpose is not what they are made for. The handles on firmer chisels should always be slightly rounded on the butt end, and it should be turned and have a ferrule on the end next the chisel. These handles are not to be pounded by a mallet; they may be tapped lightly, and the rounded end of

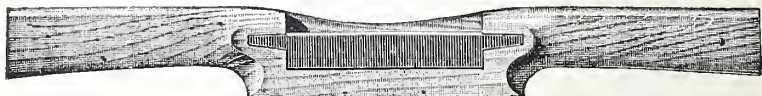


Fig. 25.—BEECH SPOKESHAVE.

the handle is then sufficient protection to prevent splitting. To use this class of chisels as mortising chisels is quite wrong.

Paring chisels should have flattened handles with the corners worked off, which would make a section of them like an elongated octagon, with two long and two short sides. A paring chisel, as shown at Fig. 27, is much longer than a firmer, and is made thin and of a fine quality of steel. The handle should be longer than the handle of a firmer, and on no ac-



Fig. 26.—FIRMER CHISEL.

count whatever should a mallet be used on it. The paring chisel is used for the finest kind of work and is guided in its movements altogether by the hand.

The mortising chisel is a heavier-made tool, and has generally, though not always, a socket on one end to receive the handle. Mortising chisels are the only ones on which a mallet is intended to be used, and the butt end of the handle is protected with a heavy iron ferrule. The handles are turned,

and the point entering the socket and the end receiving the ferrule are fitted nicely to their places.

The mortise chisel is used for clearing out the wood in a mortise hole. It is a heavy, strong tool, handled for striking with a mallet. The mortise hole is first gauged with the mortise gauge, shown at Fig. 30, and then in using the chisel the iron must be kept quite upright, and always within the lines marked; the mortise should be exactly the width of the chisel's edge. The mortising is begun in the centre of the space, working with the ground side of the chisel towards the nearest end lines, till the mortise is the depth wanted, when the chisel is reversed and the face driven straight down on the lines. The chisel must stand straight up with its face at right angles with the work, so that the mortise will be of equal breadth throughout its whole depth.

The mallet used by wood workers is made of beech, and the handle of ash. For mortising, the head is 8 in. at the outer end, tapering to $6\frac{1}{2}$ in., and $2\frac{3}{4}$ in. thick. The breadth through the eye is 6 in. The eye is made with a taper widening towards the outer end, and goes quite through the head. The handle, 8 in. long, clear of the head, is inserted from the wide or outer side. The handle is rectangular at the part within the head, and oval at the part held by the workman.

For dovetailing and many other purposes, a small mallet, $5\frac{1}{2}$ in. long, 4 in. through the eye, and $2\frac{1}{4}$ in. thick is used. It is made in the same taper form as the above, the handle being 9 in. clear of the head. These two suffice for all purposes.



FIG. 27.—LONG PARING CHISEL, WITH BEVELLED EDGES.

The firmer gouge, Fig. 28, is a companion tool to the firmer chisel already described.

Gauges used for marking parallel with an edge that has been wrought straight are the marking, the cutting, and the mortise gauge. Each has a shank about 9 in. long, with a head or block to slide along it. The marking gauge shown at Fig. 29 has a spike inserted near the end of the shank, and the movable head is fixed by a screw or a wedge at any required distance from the spike. Its use is to make a mark on the wood, parallel to an edge previously straightened, which guides the head of the gauge.



Fig. 28.—FIRMER GOUGE.

The cutting gauge is like Fig. 29, but has, instead of the spike, a thin steel blade passing through the shank, and fixed by a wedge. This blade, being sharpened, makes a cut either with or across the grain. It is used for cutting through thin wood to a given breadth, and many similar purposes.

The mortise gauge, Fig. 30, has two spikes, one fixed and the other movable by means of a screw in the end of the shank. It is used for gauging all kinds of mortise and tenon work. In using the mortise gauge, never gauge farther than to the cross lines, as it does not look neat to see the gauge line in a finished job continued beyond the mortises.

The scraper is used to take off any ridges left by the smoothing-plane in planing hard wood; it produces a surface free from lumpiness, and is used before glass-paper. It is a bit of steel plate about the thickness of a hand-saw blade; it is about 5 in. by 3 in. The manner of setting up the cutting edge for working is peculiar. The scraper is first ground to

have the edges at right angles with the sides and slightly convex in the length. After this grinding there is a slight wire edge on either side; this is removed by rubbing the

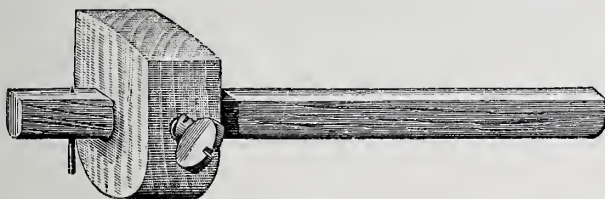


Fig. 29.—BEECH MARKING GAUGE.

scraper with the sides lying flat on the set stone, the edge is then rubbed, holding the scraper upright; the object also being to have the edge square. All the rough marks of the grindstone being now removed, the scraper-sharpener comes into use. This is a rod of hard steel about 4 in. long and $\frac{1}{4}$ in. thick, and should be very smooth and polished and is fixed in a handle. The scraper is held in the left hand, with its end



Fig. 30.—BRASS SLIDE MORTISE GAUGE.

against the bench, and the steel sharpener is applied to its edge at a slight angle, as in Fig. 31, and rubbed with firm strokes, beginning next you and ending at the bench. This turns the edge over towards the side with a fine barb. The opposite corner of the same edge is turned over in the same way, and the other edges of the scraper treated in the same way. When properly set this scraper will take a fine shaving off mahogany, 2 in. broad, at every stroke. When using it is

held with the fingers and thumbs of both hands, and the upper edge inclined forward, as in Fig. 32, the cutting stroke being in the direction of the arrow. When one edge gets blunt use another, till all four are used up, then re-sharpen.

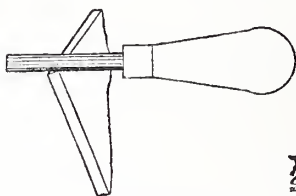


Fig. 31.
SHARPENING A SCRAPER.

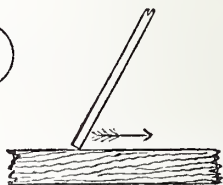


Fig. 32.
USING A SCRAPER.

Do this as follows :—Lay the scraper flat on the bench, run the sharpener smartly several times along the side of the scraper, which will turn any remaining barb towards the edge, then turn the edge over as before, and make the barb as at first. This re-sharpening may be repeated five or six times before the scraper needs re-grinding.

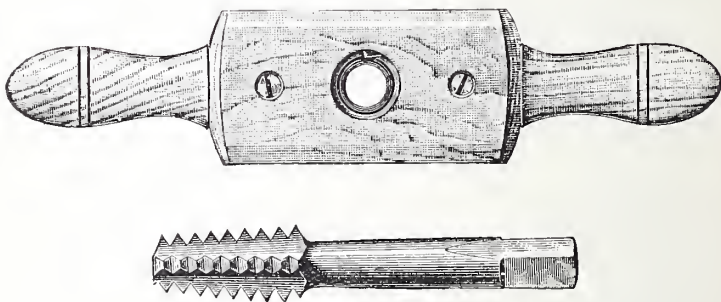


Fig. 33.—SCREW-BOX AND TAP.

Fig. 33 shows the tools for making male screws on wood and the corresponding internal thread. The screw-box will cut the thread on drawer knobs and all such like things. They are commonly sold to cut screws from $\frac{3}{8}$ to 3 in.

diameter. The tap is to cut the thread in the hole into which the male screw is to go. Taps are sometimes used with the brace.



Fig. 34.—PINNERS.

The pincers shown at Fig. 34 are useful for many purposes that will readily suggest themselves.

A veneering hammer is a necessary tool ; it is shown in Fig. 35. A piece of hard wood, 6 in. square and 1 in. thick, has a hole bored in the centre for a round handle, 12 in. long and 1 in. diameter. Slit the end wood of one edge with a thick saw, about 1 in. deep, and insert in this slit a piece of iron or steel plate 6 in. long and 2 in. broad, and fix it by two rivets passing through it and the wood. The wood is chamfered off towards the plate, the opposite part is rounded or may be formed into a kind of knob for the hand to rest upon. The sharp corner-points and edges of the iron should be rubbed off, and its edge must be slightly rounding, so as not to tear and cut the veneer when using. This kind of hammer is used for large work, as described in the chapter on veneering.

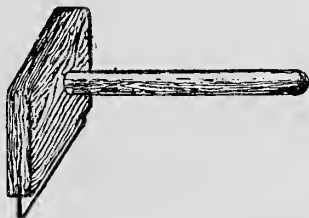


Fig. 35.—VENEERING HAMMER.

Other useful tools that properly come under the heading of this chapter are described in other parts of this book.

CHAPTER IV.

PLANES.

 PLANE, in its simplest form, is a chisel firmly fixed into a block of wood by which it is guided in its cut, and the amount of wood taken off in the form of a shaving is regulated to a nicety. In fact the tool just described is actually used sometimes, when a plane of the ordinary construction, and of a suitable size, cannot be procured.

A plane is simply a copying tool, and anyone who has had a notch in his plane-iron need not be told that the pattern produced corresponds with the edge of the plane-iron, and all the imperfections of this edge will be copied on to his stuff.

In workshop practice planes are the tools chiefly used for smoothing the surface of wood after it has been sawn to approximate size. The stocks of planes are now made both in wood and in iron. Iron planes bear the same names, and are used for the same purposes, as those made of wood, but they are more costly, and also have advantages as explained later on.

In all planing operations the edge of the tool is the pattern, which is copied in reverse on the wood. If a hollow is required to be produced on the wood, a tool is used with a round edge of exactly reverse form to the hollow we wish produced. In machine planing, the pattern is the edge of the tool, which produces a similar surface upon the wood.

In machine-moulding the pattern is the plane-iron, which is exactly the reverse of the required section of the moulding. Most of the hand planes are simply mechanical contrivances

to facilitate reproduction by copying. For example—sash-planes, ploughs, beads, hollows, moulding-planes, etc. A knowledge of this principle will enable anyone to more fully understand the reason why machinery can be more economically applied to some operations than hand labour, and why greater excellence can be obtained by machinery in all cases of reproduction by copying.

Planes were originally furnished with only one iron, they now have usually two, as shown at Fig. 45, the under one is called the cutting-iron and is for cutting the shaving, the upper is the break-iron for breaking it, so as to prevent it acting as a lever in lifting or tearing up fibres, in front of the cutting-iron. The stock or body of English planes is generally made of beech; but on the Continent apple and pear are frequently used instead. Through the stock is a vertical aperture, the lower portion of which, together with the cutting edge, forms the mouth of the plane. The projection of the iron through the mouth effectually regulates the depth to which the cutting-iron can penetrate, but it would not prevent it following the inequalities of the surface to which the plane might be applied, and doing this, it

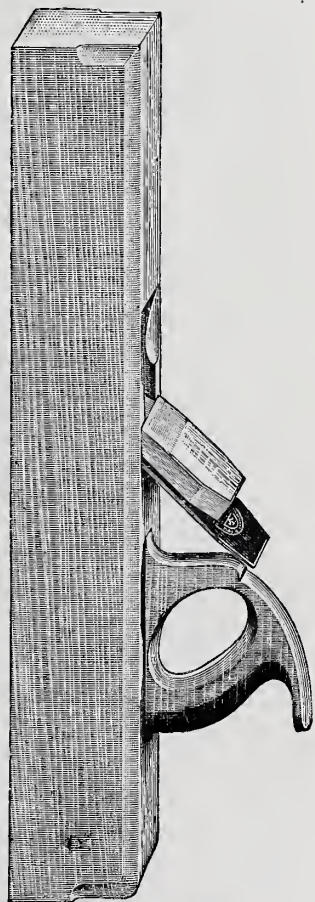


Fig. 36.—JOINTER.

would be quite unfit for the purpose for which it is intended. This is overcome by giving considerable length to the stock, so that a plane in operating on a rough piece of wood, removes successive shavings from the more prominent parts until a level surface is attained. The flatness attainable with the plane is greatly dependent on the skill of the workman. He must always try to plane "hollow" rather than round, for if a plane be flat and long in the stock, it is impossible to give any appreciable concavity to a surface of moderate size. For this reason, roughing out planes, or "Jack planes," are made as long in the stock as possible without making them too heavy and inconvenient. Planes used for "trueing," are invariably called "trying planes" and are used to correct the inequalities left by the jack. Very long ones go by the name of "jointers," and are principally used for making long joints. The smoothing plane, which is employed to give the finishing strokes to a surface which has already been flattened, is generally about 8 in. long, as explained later on.

The longest and most perfect plane used is the jointer, Fig. 36, which is like the trying plane but longer, being sometimes as much as 30 in. long, though usually about 24 in. It is used chiefly for shooting the edges of long boards. The long, straight sole of this plane serves as a guide to make long straight edges. The jointer is used after the jack plane has done its best.

The router, or old woman's tooth, is probably the other end of the list. The stock is often made of a piece of hard wood about 6 in. by 4 in. by 3 in. A taper mortise is cut through the thickness of the wood to accommodate a cutter $\frac{1}{2}$ in. wide with a wedge behind it. A piece is cut out of the middle of the sole in front of the iron, to allow the shavings to escape. These are all the essentials, though a handy and graceful shape is generally given to the stock. This tool is to plane

out grooves of any required depth, which is done by tapping down the iron at every fresh cut until the full depth is reached. Cutters of differing shapes may be employed and guides may be screwed to the sole; with these, recesses may be worked out having a curved form at the bottom, and always in a definite position in any number of pieces. It is slow in its action and liable to chatter when the iron extends far below the sole.

The trying plane is like the jointer, Fig. 36, but shorter: it is usually about 22 in. long; the longer sizes being called jointers. A plane, 24 in., is a suitable length for ordinary purposes, and serves both for trying and jointer. These planes have an iron, like that shown at Fig. 45, $2\frac{1}{2}$ in. broad

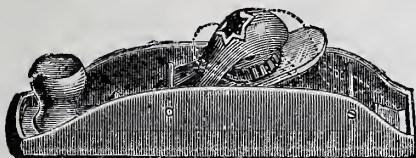


Fig. 37.—COMBINED BULL NOSE AND SMOOTHING PLANE.

and a handle slightly different from the jack. The trying plane is used for dressing the wood after the jack, as it produces a more even surface. It is also used for squaring up and bringing the pieces to the desired measurements previous to framing them together; its great length makes it well adapted for making long pieces practically straight on the edges; and for joining two or more pieces together, to form a broad piece, it is indispensable. Iron trying planes, being planed truly accurate on the sole, make long joints with much greater facility, and do not get out of truth like the wooden ones.

Iron planes have a decided advantage over wooden ones for many purposes; a great variety are now imported from America, generally made of cast-iron. Home-made ones are of malleable iron, often filled in with wood, giving them a

more substantial appearance. American are largely used, being cheaper and generally lighter to handle.

As an example of various uses to which an iron plane can be adapted, Fig. 37 shows an American plane having two distinct slots, or cutter seats, so that the iron can be shifted to form either a bull nose plane or a smoothing plane.

Some iron planes are a little heavier than wooden ones. A touch of oil makes the iron planes glide over the wood like a skate over a piece of ice. Before the introduction of

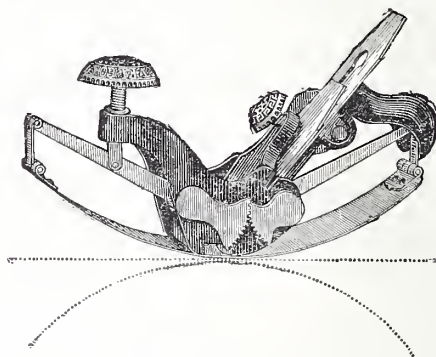


Fig. 38.—ADJUSTABLE CIRCULAR PLANE.

iron planes we had nothing adjustable to plane circular curves. A bow, or compass, plane would fit a circle, but it would fit only the one curve it was made for. Fig. 38 shows a plane with a spring steel sole, which may be adjusted to suit any circle down to 13 in. diameter, internally or externally. It is the pioneer plane of its kind.

The seat of the plane iron is made at different angles, to give the pitch to suit different kinds of work; the four angles most in use are known as common pitch, in which the seat for the back of the iron is at an angle of 45° from the sole, and this inclination is usually employed for all planes for soft wood. York pitch has an angle of 50° , and is adapted for use

with mahogany and other hard stringy woods. Middle pitch, or 55° , and half pitch, or 60° , are employed with moulding planes, the former being for soft wood and the latter for the harder kinds.

Though some people still prefer wood, yet iron planes, having several good points which the wooden planes have not, are deservedly making their way. As already explained, unless a plane is straight we cannot expect to plane straight with it. A round plane planes hollow, and a hollow plane planes round. A wooden plane is constantly changing its shape, in a more or less perceptible degree, from causes that are constantly operating—the tension produced by the wedge, the dry or moist state of the atmosphere, and the wear of the work. It is not unusual for a workman, who has some particularly accurate planing to do, to commence by first “trueing”



Fig. 39.—BULL NOSE PLANE.

his plane. Every time the sole of a plane is dressed, the mouth becomes a little wider, and at last gets so wide that shavings stick and trip the plane out of its cut. A plane with a wide mouth has a tendency to cut deeper than set for, when it approaches the end of the board.

An iron plane practically does not wear at all. There is no wedge to spring it; it is not affected by the weather, and its mouth remains the same size. With a mouth so fine as it is possible to make these, and by reversing the position of the cutting iron, so as to give it a pitch of about 50° , the use of the top iron is not needed at all, as in Fig. 39. The iron plane gets up a smooth surface on hard wood much better than the wooden one. The iron plane always has an advantage over a similar one of wood; and a bull nose plane, like Fig. 39, cannot be made of wood. This last-named plane has

the iron reversed in the stock and the cutting edge brought close up to the end, so that the plane can be used in confined places and near to a moulding or other projection.

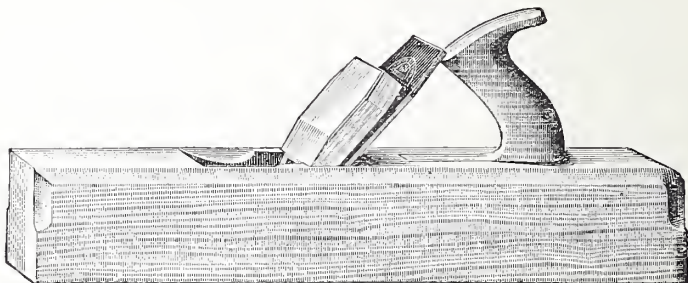


Fig. 40.—BEECH JACK PLANE.

The jack plane is the first applied to the wood after it has been sawn. The wooden jack is shown at Fig. 40 : it is 17 in. long, and has an iron or cutter $2\frac{1}{8}$ in. broad. Immediately behind the iron is a handle, which, in use, is grasped only by the right hand in planing fir ; but in heavy planing, and especially in hard wood, it is necessary to place the left hand

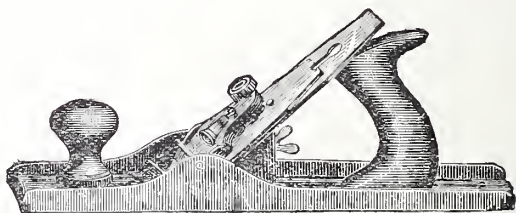


Fig 41.—IRON JACK PLANE.

across the front of the plane to press it down, to cause the iron to take hold of the wood. When using both hands to the plane, the left is placed with the four fingers lying across the top near the fore end, the thumb passing down the near side. The iron jack plane is shown at Fig. 41.

The smoothing plane is used to put the finishing surface on work. After the drawing in, mortising, tenoning, dove-tailing, etc., have been done, and before work is put together, all

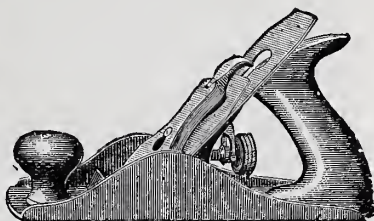
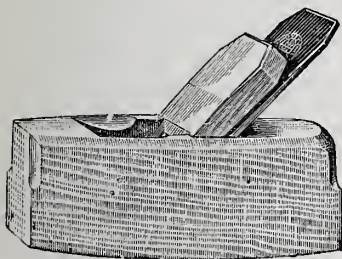


Fig. 42.—WOOD SMOOTHING PLANE.

Fig. 43.—IRON SMOOTHING PLANE.

the parts that cannot afterwards be operated upon, are finished with this plane. For fine or other soft woods it is 9 in. long, having an iron $2\frac{1}{4}$ in. wide on the cutting face. The stock of this plane has the sole and top parallel, but the sides are curved, making the two ends narrower than the centre. Fig. 42, shows the usual form.

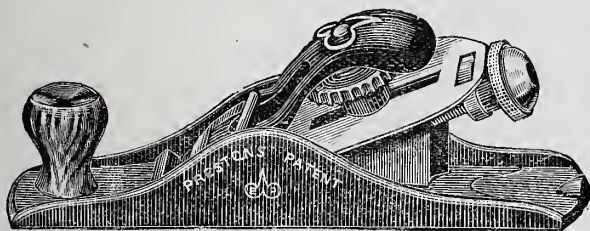


Fig. 44.—IRON PLANE.

The irons are held in place by a wedge, but this plane has no handle, and when using, it is held by both hands, the right behind and the left before the wedge; occasionally it is necessary to hold or steady the work with the left hand, then the right grasps the back part of the plane.

The American iron smoothing plane, as shown at Fig. 43, has a handle similar to a jack plane. An English-made iron plane is shown at Fig. 44; it has an adjusting screw, by which the cutting iron can be moved backwards or forwards to a nicety, and the means used to fasten the iron is very simple and effective. The plane is light, and can be used with one hand. It is valuable for smoothing cross-grained hard woods, and many other purposes. For hard woods the shape is the same as the above, but only $7\frac{1}{2}$ in. or 8 in. long, with a 2-in. iron set at a higher pitch—that is, it does not slant back so much. This plane is used for the

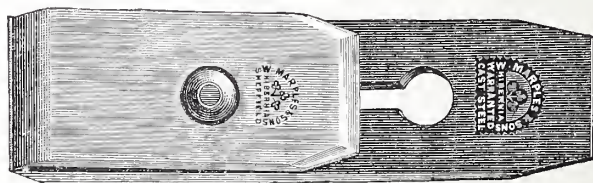


Fig. 45.—CAST STEEL DOUBLE PLANE IRON.

same purpose in the finishing of hard woods as the other is for pine.

The plane iron is shown at Fig. 45, and in grinding the edge, care should be taken to use a true-faced grindstone, and a flat oilstone. To remove the iron from the stock: the wedge is released by giving the stock a smart blow or two on its hinder part if the plane be of the short kind, or by a stroke on the upper front surface if it belongs to the long class; the double iron is then drawn from the aperture, the screw by which the cutting iron and the break iron are united loosened, and the irons separated. The break iron having once been sharpened will require no further attention, as it lies against the cutting iron in such a position as to protect its edge effectually from ever getting blunted. The cutting iron should

be ground on the stone to a flat cutting edge at an angle of about 25° and then finished on the oilstone to form a fresh "facet" or bevel, making a more obtuse angle with the line of the iron, say about 10° to 15° more, so that the inclination of the actual cutting edge will be about 35° to 40° . In replacing the break iron on the cutting iron, the kind of work for which it is to be used must be borne in mind. If the break iron is brought very close to the edge of the cutting iron, the shaving is broken more abruptly, and the work is less liable to tear up; but the labour expended will be greater. As a rule, for roughing out, the edges may be somewhat distant, say almost up to $\frac{1}{16}$ in. apart; but for finishing, the break iron edge should be almost level with the edge of the cutting iron.

In wooden planes the iron shown at Fig. 45 is fixed in its place in the stock by blows of the hammer on a wedge, and it is loosened by blows upon the plane itself. Two taps should loosen the wedge and the iron; to remove the irons for sharpening, the plane is tapped on the upper side, near the fore end, with the hammer. In setting the iron after sharpening, the back end of the plane is tapped to give more edge; and to give less, the fore end of the plane stock is tapped gently. To set the edge evenly with the mouth, the iron is tapped on the edge behind the wedge. During this process of setting the iron the eye glances along the sole of the plane, the end resting on the bench. A little practice enables the operator to set an iron very quickly. In the course of time the mouth of a plane gets considerably enlarged and out of truth, it may be to some extent prevented by keeping the sole slightly greased—rubbing it over with a piece of bacon rind is a favourite plan; but when the mouth gets too wide it must be made narrower, which can be done by letting in a piece of boxwood in front of the cutting iron. Some wooden planes,

especially those used by cabinet-makers, have the sole made either entirely or in great part of brass or iron. Owing to the process of hammering to adjust the iron, no tool on the

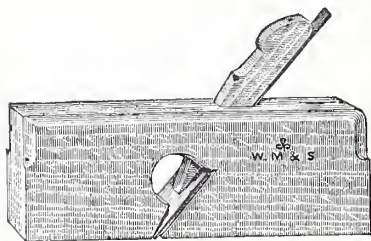


Fig. 46.—WOOD REBATE PLANE.

bench has a more worn and battered appearance than the plane. Blows of a hammer deliver a very uncertain pressure. A wooden plane might be true when three blows were struck on the wedge ; a fourth blow might curve it. In an iron plane, the

knife is held down by an easily regulated pressure ; the depth of cut can be regulated to a nicety and with the greatest ease by means of a screw.

Rabbet, or rebate, planes are used for cleaning out the square angular corners of mouldings, checks for panels, etc. For hard wood this plane is $\frac{7}{8}$ in. broad, the cutting it makes being of the same breadth ; the mouth runs square across the sole.

Fig. 46 shows this plane. For soft wood it is $1\frac{1}{4}$ in. broad, and has the mouth and cutter running obliquely across the sole, and the iron is not so high in "pitch" as for hard wood.

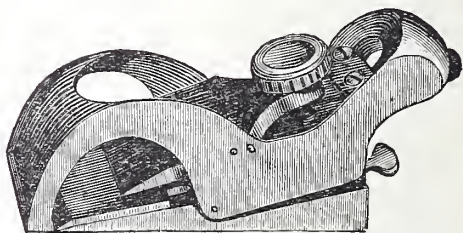


Fig. 47.—IRON BULL NOSE RABBET PLANE.

The iron rabbet planes are made with the soles from $\frac{1}{2}$ in. to 1 in. wide ; a bull nose rabbet plane is shown at Fig. 47. A useful size is $\frac{5}{8}$ in., which has two irons, one being near the

front. The fillister is a rabbet plane with a "fence" and a guide for working to a given depth and width ; it is an expensive plane, as may be inferred from the illustration, Fig. 48.

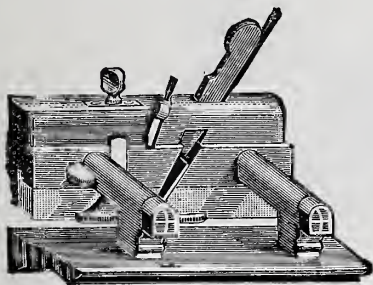


Fig. 48.—FILLISTER PLANE.

Planes for making half-circular beads and grooves of the same shape are called hollows and rounds, and they are very useful, as with them mouldings may be worked. These planes somewhat resemble Fig. 46, the irons being as illustrated at Figs. 49 and 50. They go in pairs, each round



Fig. 49.—HOLLOW PLANE IRON.



Fig. 50.—ROUND PLANE IRON.

having its corresponding hollow ; and there are sixteen pairs in a full set, from $\frac{1}{8}$ in. to 2 in., which means that the radius of the hollow and of the round are these sizes. Eight pairs, or a half set, are generally used ; they are the alternate sizes.

The bead plane is a small plane with a hollow along the centre of the sole. The central portion is filled in with boxwood, in which the hollow groove is made the size of the

bead. This plane is similar in its effect to the hollow plane last described.

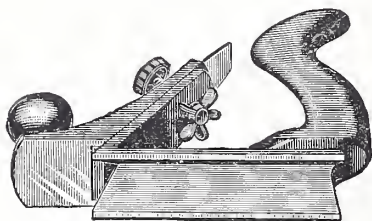


Fig. 51.—ADJUSTABLE CHAMFER PLANE.

Bead and other moulding planes are generally set ready for use when bought ; but when they require sharpening, this is done with a stone called a slip.

Several of these slips are necessary, having different shapes to suit the various bead and other moulding planes. They resemble gouge-slips, are usually about 6 in. long and 2 in. broad, and from $\frac{1}{8}$ to $\frac{1}{2}$ in. thick. They have the edges rounded to suit the irons to be set. The cutting part of a bead-plane iron is something like a semicircle, and is a little smaller than the corresponding curve in the stock of the plane, the difference being the thickness of the shaving taken off. When the iron has been set a number of times with the slip, the curve is likely to get wider, and consequently is soon as wide as the curve in the stock. The iron will not then take off a shaving of equal thickness throughout the whole

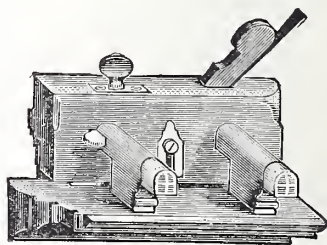


Fig. 52.—PLOUGH PLANE.

curve, but thickest in the middle, so the iron must be reground by the tool grinder, who has very thin round-edged grindstones for the purpose, and set anew. The same thing occurs with most of the other moulding planes. In setting an ogee, for

instance, which consists of a curve called a "hollow-and-round," with the slip, the hollow part is continually getting wider, and the round part which is set on the ordinary set-stone is getting blunter. From these causes the moulding gets out of proportion and unsightly; besides, the iron does not fit the stock with an even-cutting edge throughout its whole breadth, and will not turn a good shaving as before. The tool-grinder will take it in hand, and regrind the iron when in this condition.

Chamfer planes are used to take off the arris in various framed work. Fig 51 shows an American plane arranged to

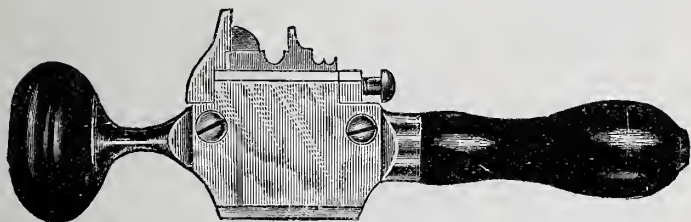


Fig. 53.—REEDING TOOL.

cut chamfers to any ordinary width. The front part of the plane carries the cutter, it slides upon the back part, and can be chamfered where desired. This plane forms an ordinary bench plane, with the front part brought down to be level with the back.

The plough is used to make plain grooves, one like Fig. 52 has eight irons, ranging from $\frac{1}{8}$ in. to $\frac{5}{8}$ in. wide. It has a moving "fence," and is used for all kinds of joining by feather and tongue, and in any other work with the groove running with the grain of the wood.

Match ploughs are not adjustable; they are sold in pairs, one to cut the groove and the other to cut the tongue. Pairs of match ploughs, from $\frac{3}{8}$ in. upwards, are useful.

A mitre plane is the kind to use on the shooting board and mitre block, as illustrated on page 29. It has the iron $2\frac{1}{2}$ in. broad, which lies very flat down, and has the ground side uppermost like the bull nose plane; and the opening in the sole is a narrow slit. This plane is the best for hard wood, but good work may be and is done with the trying plane for the shooting board, and with the smoothing plane for the mitre block.



Fig. 54.—CUTTERS
FOR REEDING TOOL.

The reeding tool, Fig. 53, is perhaps almost out of a list of planes, but its purpose is to plane mouldings, though it has not any guiding stock. The cutters shown at Fig. 54 are fitted into the handle, being arranged so that the various forms of cutting edges together make a continuous edge of the form desired to plane the moulding wanted.

Some moulding planes have a deep fence that comes over the front of the moulding board, such as the quarter round, the Welsh ogee, and others. Other moulding planes have a narrow fence, only the thickness of the finished edge of the moulding. In running a moulding, the operation is continued till the plane rubs upon the surface of the moulding board, the back fence, at the same time, rubbing upon an untouched part of the moulding, or upon the guide bar. Thus any number of mouldings are run off exactly the same size, providing that all the pieces of wood have been prepared alike.

The toothed plane is peculiar: it has a stock similar to the hard wood hand-plane, but the iron, instead of having a straight cutting edge, presents a series of sharp pointed teeth

to the wood. This serrated edge is formed by long narrow grooves on the face of the iron next the wedge, and when the iron is ground in the usual manner the ridges terminate in sharp points. In setting-up this iron on the oil-stone, only the back is ground on the stone. This iron is nearly perpendicular in the stock, so that it is simply a scratch plane, and so needs no cover, like the others do. The toothed plane is to roughen the surfaces of pieces to be glued ; it takes off the ridges left by the ordinary plane, and it roughens the surface, thereby adapting it better to hold the glue.

Apart from the common planes enumerated, there are many others, and some of them cannot well be dispensed with in special work, though of little use for general purposes.

CHAPTER V.

BORING TOOLS.

 BRACE and bits furnish the best assortment of boring tools for cabinet work. Various implements fitted to the brace and used for boring holes are named bits. Those which are of most general use to the wood-worker are described under their various specific names, arranged alphabetically. It is better to buy the bits with the brace, as they are fitted and are more truly centred than those bought separately are likely to be, and the centring of the bits is essential to their proper action. To see if centred, fix the brace, with the bit in, in a vice by the head or cap; then rotate the brace, and observe if the bit turns concentricly.

Braces are sold separately, such as are shown at Figs. 55, 56, and 57, or fitted with 12, 18, 24, 36, or 48 bits; the bits being either bright, black, or straw-coloured, the last being the most expensive, but not necessarily better for use than the black, except that in bright bits you can at once see if they have any flaws. All common bits cost about 4*d.* each, centre bits above 1 in. increase rapidly in price. Bits sold in sets of from 1 to 4 dozen average about 2½*d.* apiece for good medium quality. As a rule they do not require sharpening; if slightly notched they may be repaired with a sharp file. In boring with fine bits use a little grease, pull out the bit and remove the core occasionally; if the bit gets fixed, take off the brace and pull out with pincers. All boring tools may be heated so much as to spoil their temper when in use.

The brace supplies the most useful boring tool; from the

variety of bits that can be used with it, it serves many purposes. Bits that fit it are used to bore holes for nails, screws, or pegs. To cut circular holes, such as the circles for

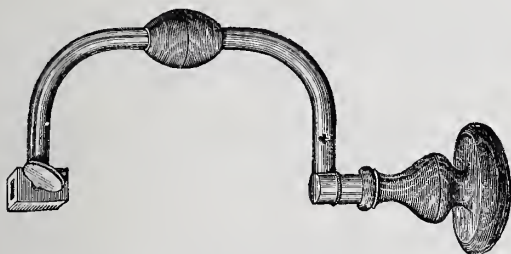


Fig. 55.—IRON BRACE WITH WOOD HANDLE.

coins in cabinets, or for bottles in chemical cabinets, or for test-tube stands; also for circles which may be used as ornaments. Wood may be also cut away in roughing out carving, frequently more quickly and certainly by the aid of a brace and bits than by any other means. Mortises are often better cut by first boring away the bulk of the wood; such a proceeding prevents splitting.

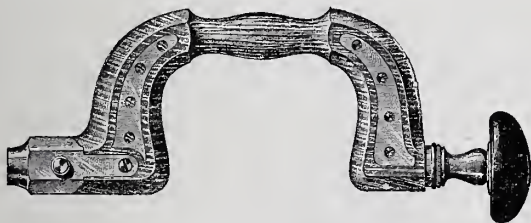


Fig. 56.—PLATED BRACE, WITH BRASS NECK HEAD.

The brace itself is made of iron, or of iron and wood, or of wood only, with brass plates where greater strength is required. Illustrations are given of each kind. The cabinet workers' brace should be made of wood, like Fig. 56; it consists of a crank, octagonal in section, having a round

portion in the centre to use as a handle ; the ends of the crank form short pieces in a line forming the axis. One end has a brass plate on it, and a steel rod. This rod, which has a ball at the end, forms the axle for a round flat knob, called the cap, turning freely on the steel rod, and prevented from coming off by the ball, the two surfaces of brass being separated by an iron washer that turns freely. The other end of the brace has a square steel socket in which the bits are used ; this end being called the nose. A spring catch on one side fits into a notch filed in the bit.

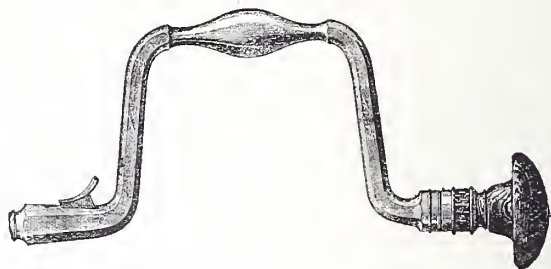


Fig. 57.—SCOTCH PATTERN BRACE.

The brace can be used to bore vertically or horizontally. The greatest force is obtained in the latter position, holding the cap with the left hand, and pressing with the stomach, leaning against the tool. It is quite possible to break a brace by pressing on it too strongly. An iron one may bend, and if bent the bit is made eccentric. To bore vertically, the work should be low, so that the operator may lean over the top of the brace, and, holding the cap in the palm of one hand, press on the back of the hand with the right shoulder and turn with the other hand.

The American chuck brace is iron with a hard-wood cap and handle ; the chief difference is in the nose, which, instead of being solid with the rest, is turned by one of two ratchets,

so that it can be turned in either direction. This brace can be used in a corner where the ordinary brace will not turn, this ratchet allowing a backwards and forwards motion which is a decided advantage. The chuck which holds the bits consists of two flat jaws joined at the back by a wire spring, and coned on their edges, over which a hollow cone cap screws, and



Fig. 58.—SINGLE TWIST AUGER-BIT, WITH SPUR NICKER.

as this is turned the jaws open or close and grip the bit accurately. But sometimes it requires time to get the bit nicely centred. These jaws hold the Morse drills fairly well. It is a useful tool to have in addition to the ordinary brace.

The cheapest style of brace is shown at Fig. 55, and the Scotch pattern, all iron except the cap, at Fig. 57.

The most usual forms of bits which may be used in any brace are illustrated and described in the following paragraphs—arranged in alphabetical order :—

Auger-Bit.—One having a twisted shank, which, from its



Fig. 59.—SCREW AUGER-BIT, GEDGES' PATTERN.

spiral form, screws the chips out of the hole it is boring, and so obviates the necessity of withdrawing the bit to clear it from chips. Auger bits consist of the shank, then the spiral twisted piece, and a tapering screw point; the end of the spiral is shaped to a sharp cutting edge, a small piece at the extreme outside being left to form a tooth called a nicker, which cuts a clean circle. Two forms are shown at Figs. 58 and 59. Augers bore well in the direction of the grain of the

wood, but centre bits will not do so in most woods, unless they have a screw in place of the pin.

Augers are made complete in themselves, and used to bore holes of considerable depth and size in wood. One consists of a steel rod, having a round eye one end through which a round wooden handle fits at right angles; at the other end is a spiral twist of larger diameter, terminating in a conical screw with a sharp point; the edge of the spiral is a nicker which cuts the grain of the wood around the edge of the hole. When using an auger, most power is obtained by standing over the work and boring downwards; a little grease should be used with it. Large augers are not much used in cabinet work; small auger



Fig. 60.—CENTRE-BIT.

bits are fitted to the brace, and these are sufficient for most purposes.

Centre-Bit.—This boring tool is one of the most useful bits, and used very generally in all kinds of wood-working. It has a central triangular pin, which serves to guide the bit, and two wings, as shown at Fig. 60. One of these, called the nicker, acts as a scriber which cuts a ring round the central pin; the other is a router, which tears up the wood within the circle made by the scriber. The pin is not quite in the centre, and so the circle cut is of larger diameter than the width of the tool. To gauge a centre-bit, measure the distance between the nicker and centre of the pin, but not so as to get an oblique measurement. To be exact, bore a hole in a piece of waste wood similar to the kind being worked on, and measure this. Large centre-bits have two, and very large ones

even three nickers on one side ; these bits are expensive. If it is required to cut circles out of thin wood, of greater diameter than 3 in., they may be cut by a tool like the knife



Fig. 61.—FLAT COUNTERSINK OR CHAMFER.



Fig. 62.—SNAIL HORN COUNTERSINK.

of a cutting gauge, fixed to an arm that rotates on a pivot fixed on a block of wood, acting like beam compasses. In boring with centre-bits see that the chips rise out of the hole ; if not, remove the bit and shake out the pieces, or the chips may wedge against the tool, when the hole will run on one side or the bit be broken. The pin of a centre-bit may be re-pointed if it is blunt—observe the section is triangular ; and sharpen the nicker, if necessary, from the inner side.

Countersink-Bits, also called chamfer-bits, are used to recess a conical hollow, such as that to receive the head of a common wood screw. Countersinkers are of various kinds, one with the point like a drill for metal, as shown at Fig. 61. ; another is shaped like a cone, and is cut with furrows and called a rose head ; another form is shown at Fig. 62, it has one groove only ; they are useful to the cabinet worker to sink the holes for screws in brass work, so that the heads of the screws fit snugly. A form of countersink for wood consists of a brass cone with a projecting knife ; at the side is an adjustable stop that regulates the depth countersunk.

Cone-bit.—These are tapering cones, the section being a crescent. They are used to enlarge holes already bored, and make them tapering.

Dowel-bit.—This is similar to and also called a spoon-bit and a duck's-bill-bit, but shorter, and with a round point. It has a semicircular stem, the section being crescent-like in

form, with the end formed conical to make a cutting edge. This is an improvement on the gouge bit. Dowelling bits are used by table makers to make the holes for the dowel pegs in the leaves of tables; also by coopers to join the heads of casks. Small bits of this form are called pianoforte-bits.



Fig. 63.—PIANOFORTE-BIT.



Fig. 64.—SPOON-BIT.

To make dowel-pins, the dowel-plate is used; it is a steel plate about $\frac{1}{2}$ in. thick, with holes from $\frac{3}{16}$ in. to $\frac{1}{2}$ in., and the bits correspond so that dowel-pins made in the holes will fit holes made by the corresponding bits.

Drills.—They may be often used on wood, where other tools, such as awls or gimlets, would split the wood. Twist drills are excellent, but those with round shanks cannot be



Fig. 65.—TWIST DRILL FOR WOOD.

held in the ordinary square hole brace. The American drill shown at Fig. 65 is particularly useful for boring holes through wood where several pieces join, as the drill will not run out of its true direction. The centre and the cutting lips can be re-



Fig. 67.—NOSE-BIT.

newed as they wear, and this drill can be used in the American brace.

Duck's-bill-Bit.—A half round hollow bit, the end of which terminates in a conical point. Very like, and sometimes called dowel-bit and spoon-bit.

Expanding Bit.—This is useful when a number of various-sized holes have to be bored. It works like a centre-bit, but with the nicker movable, being fixed by screws, and has a scale to show the size. It is expensive, and requires to be used with great care.

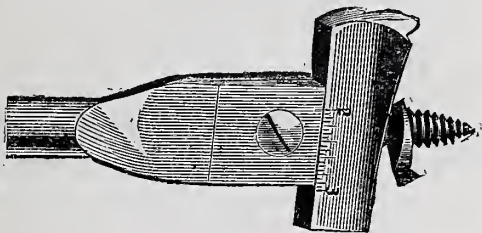


Fig. 66.—EXPANDING BIT.

Fig. 66 shows an expanding bit particularly handy for boring holes of unusual diameter, it being adjustable to any size within the limits of its range. Two sizes are made, one boring from $\frac{1}{2}$ in. to $1\frac{1}{2}$ in., the other from $\frac{7}{8}$ in. to 3 in. It is an American tool.

French-Bit.—This boring tool approaches the drill used for metal in form; it is used for boring hard woods. A round steel rod, flattened at the end and ground on both edges to form a long point, forms the French-bit.

Gouge-Bit.—A quill-bit, or shell-bit, which has the end like a carpenter's gouge.

Nose-Bit.—This is similar to the shell-bit, but it has a cutting lip at the end, as shown at Fig. 67.

Pod-Bit.—This is semicircular in form, and the end of the hollow stem has a cutting lip to it.



Fig. 71.—CONE, OR TAPER-BIT.

Quill-Bit.—This is a gouge-bit or shell-bit of small size, and is so named probably from its resemblance to a quill.

Reamer-Bit or taper-bit is a tool for enlarging holes for wood;

it consists of a hollow, tapering semicircular piece of steel coming to a sharp point, as shown at Fig. 71. For metal, a tapering steel, usually square or half-round in section is used.

Sash-Bit.—This is a long nose-bit as shown at Fig. 68, and is used to bore end-ways of the grain in sash frames to make the holes for the cords of the sash weights. If the bit has a



Fig. 68.—SASH-BIT.

sharp cutting tooth at the end it is called a nose-bit, and a parallel nose-bit, the same thickness to the shank, the edges being quite parallel, is a sash borer.

Screwdriver-Bits are useful, and should always be included in a set; the leverage of the brace is great, and for driving long screws it is quicker than a screwdriver. Screws may be easily taken out with it that seem immovable with an ordinary screwdriver. A forked screwdriver, with a notch in the middle, for use with nuts in which the screw projects, as in saw handles, is contained in a complete set of bits, but it is not often required.

Shell-Bit.—A gouge-bit or quill-bit. This is a plain, semicircular hollow stalk, with the end terminating in a sharp edge, like a carpenter's gouge, as shown at Fig. 69. When the end is brought to a point, it forms what is called a dowel-bit.



Fig. 69.—SHELL-BIT.



Fig. 70.—TWIST-NOSE BIT.

Spoon-Bit.—Also called dowel-bit and duck's-bill-bit, and described under the former name. See Fig. 64.

Twist Nose-Bit.—This bit is of the shape shown at Fig. 70, and it serves the purposes of ordinary twist gimlets.

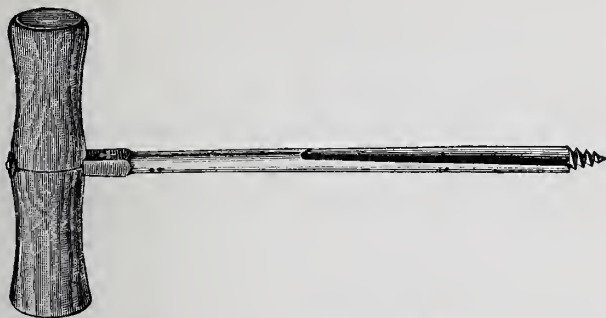


Fig. 72.—SPIKE SHELL GIMLET.

Having enumerated the bits used in the brace, we have still left the most common of all boring tools, viz.: bradawls and gimlets.

The awl, or bradawl, is a piece of round steel, having at one end a shoulder and a tang, by which it is fastened into

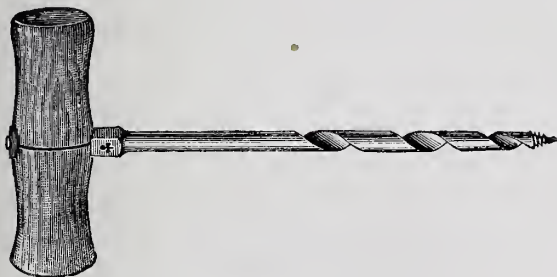


Fig. 73.—SPIKE TWIST GIMLET.

a handle of wood. The bradawl varies in diameter from the size of a needle to $\frac{1}{8}$ in., or more; it compresses the wood around the opening, but does not remove any, which is an

advantage when a nail is to be driven in; but on the other hand it tends to split the wood. Bradawls should be kept sharp.

Gimlets are made in two forms commonly, as shown at Fig. 72 and Fig. 73, though the form shown in the twist-nose bit, Fig. 70 is also used. The twist gimlet, Fig. 73, is the better form, and also the more costly. All sizes of the different patterns are used, though small ones are more general, the bits used in a brace serving for boring large-sized holes.

CHAPTER VI.

JOINTING AND GLUEING.

JOINTS are admittedly the weakest parts in structures, though they are also unavoidable. The following pages contain illustrations and particulars of joints that commonly interest the cabinet-worker. A dozen of the illustrations are borrowed from "A Practical Treatise on the Joints made and used by Builders," by W. J. Christy, a volume in Weale's Rudimentary Series, published by Messrs. Crosby Lockwood and Son. It contains upwards of 160 illustrations of the joints used in all the mechanical arts, and concise descriptions of them, and forms a very handy book of reference on the subject.

All who are interested in woodwork, and the principles by which the different parts of any framework are connected, find the process of joining one piece of wood with another a very instructive study; and those who exercise their ingenuity in the constructive arts, and especially in making repairs about the home, should give particular attention to the formation of the joints by which the different parts are united. Everyone who has taken any special interest in this branch of work develops peculiar notions of his own, and if notes were made of the different special methods of mitring, notching, dovetailing, etc., a variety of curiosities would be discovered. When joining the sides of a chest with the ends, or the fronts and sides of tills, or the drawers in furniture, the methods adopted are often peculiar to the workman. In dovetailing alone there are a dozen ways of accomplishing the simple method of

joining the ends of two pieces that meet at an angle. A pure dovetail joint really only holds the sides from pulling from their ends, and does not prevent the ends leaving the sides under pressure, and it would seem impossible to have the dovetail projections bevelled both ways, so as to hold both in their places; it is, to all appearance, accomplished in the manner shown in the engravings at Figs. 78 and 79. We hear of the blind dovetail, the half blind, the straight, the square, the rectangular, and the undercut, and many others that are not known by definite names. Generally, these joints are arranged for the fantail projection to resist thrust only in one direction. The carpenter often exercises a great deal of ingenuity and skill in the simple matter of joining one piece with another to form a beam for timbers not commonly found of sufficient length for building purposes, and the variety of joints of this kind are as varied as the woods they connect. The principles which should be considered in designing joints and fastenings, when strength is requisite, are concisely as follows: To cut the joints and arrange the fastenings so as to weaken the pieces of timber they connect as little as possible. To place each abutting surface in joint as nearly as possible at right angles to the pressure which it has to bear. To proportion the area of each surface to the pressure which it has to bear, so that the timber may be safe against injury under the heaviest load that occurs in practice. To form and fit every pair of such surfaces accurately, in order to distribute the stress uniformly. To proportion the fastenings so that they may be of equal strength with the pieces which they connect. To place the fastenings in each piece of timber so that there shall be sufficient resistance to the giving way of the joint by the fastenings shearing or crushing through the timber.

Dovetailing is, probably, the most general form of jointing in cabinet work, and the method of making this joint will be

well understood by the following description of how to dovetail together the ends and sides of a drawer. To begin, first mark the wood from which you make the front of the drawer, on the outside thus, Λ , when you will always know the edge to be kept uppermost. Plane the bottom edge straight, then, assuming that the aperture to which the drawer is to be fitted is rectangular, cut one end off square. Place the front, with the squared end in its place, against the aperture, and draw the other on the inside with the marking awl. Saw off and

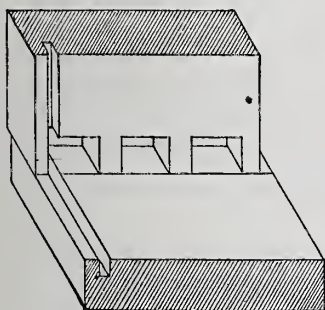


Fig. 74.
DOVETAILS IN DRAWER FRONT.

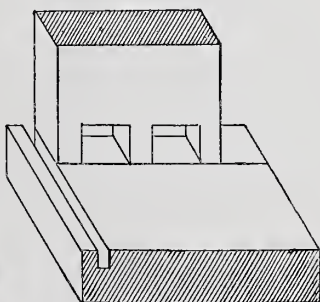


Fig. 75.
DOVETAILS IN DRAWER BACK.

square this end with the plane on the shooting board. Having got the ends to the exact length, place the front against the aperture again, letting the lower edge enter a little way. Draw along the upper edge inside, and plane down to this mark. The front should fit tight, and at present it is sufficient if it just enters. Cut out two sides for the drawer, say of $\frac{5}{8}$ in. wood, dress and square the ends, on the shooting-board, $\frac{1}{2}$ in. shorter than the distance from face of rail to inside of back rail. These sides may be at present a little broader than the finished size. Groove the sides and front with a drawer-bottom plane, and make a back exactly same length as the front, but 1 in. narrower; it is also $\frac{5}{8}$ in. thick, but is

not grooved like the sides. Having the front, sides, and end prepared, set the cutting-gauge to a shaving less than the thickness of sides ; gauge all the pieces with this—the fronts on the inner face and also on the end wood, gauging from the inner side only, then the back and sides on both sides. Mark on the front four pins, as in Fig. 74, and on the back three pins, as in Fig. 75, down to the gauge lines. Both sides and also the back are cut from both sides, as is all *through* dovetailing, while the front is cut only to a depth of $\frac{5}{8}$ in. In

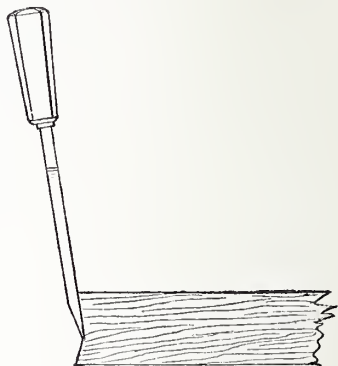


Fig. 76.—PARING A DOVETAIL.

sawing out dovetailing, the thickness taken by the saw kerf must come out of the piece to be cut out—the piece being cut out exactly within the lines, so that the pins from which the lines were drawn will fit exactly into the openings thus made. *Through* dovetailing is cut from both sides, and the chisel is inclined slightly, as shown at Fig. 76, to cut inwards, which allows the edges to come closely and neatly against the



Fig. 77.—DOVETAILS IN DRAWER SIDE.

adjoining part when glued up ; this is called making it “lean” in the centre.

The same remark applies in dovetails, *not*

through, as on the drawer-fronts, which are slightly “lean” at the bottom both ways—from the face and from the end. For dovetailing, firmer chisels are used ; they must be thin and sharp, and are struck gently with the wooden mallet.

To draw the dovetails on the sides, place the side flat on the bench, groove upwards, and stand a front on the end of the side flush with gauge line, and flush with bottom edge. See Fig. 74. Draw close to each pin with the marking awl, reverse the front, and draw on other side same way. Turn the sides end for end, and draw the back in the same way, having each piece marked so that you make no mistake when fitting the drawer together. Fig. 75 shows that in drawing the back dovetails, the back is placed even with the groove in the side, as the bottom slips in under it, the groove in the sides being clear of the back to receive the bottom. The pieces taken out of the sides are ripped with a dovetail saw, and cut off with a $\frac{3}{8}$ in. chisel ; there are three of these pieces at the back end, and two at the front end, with two corners cut out, as shown in Fig. 77. The dovetails should be cleaned out with narrow chisels, and the corners of the sides pared to the gauge lines after sawing off.

The drawer stuff, all dovetailed, is planed on the inside and sandpapered ; then try the fronts and backs and see that they enter their respective sides ; then glue them together in the following manner, which is good for all work of a similar kind : Take the front and one side ; with a small brush put some glue into the recesses in end of front, taking care to allow none to get on to the inner face ; also put a little on the end wood of the side and on the two corners ; stand the front, glued end up, on the bench ; enter the side, and drive it home with hammer and a bit of wood ; now turn the work over on the bench, the side standing vertical, see that the join inside is perfectly close, gauge with a large square inside, and press the side to agree with the square. This done, take the back belonging to this drawer, put glue on the pins to enter this same side, and drive home as with the front. Now glue the free ends of front and back, and drive on the second side.

See that the inside joints are all close. Lay the drawer flat down on the bench, and square it by measuring with a foot-rule, applied from corner to corner, and let it stand for the glue to dry.

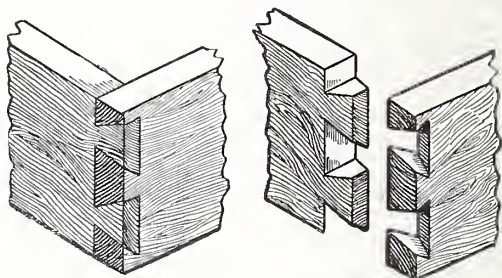


Fig. 78.—PUZZLE DOVETAILING.

In some specimens of dovetailing it will be noticed that the projecting pins of the ends, as they appear on the sides of the box, are not so thick as the ends themselves, and the joint appears dovetailed in both directions, and to show like this it

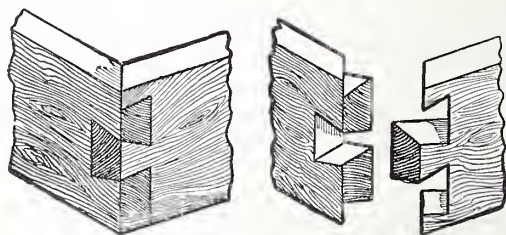


Fig. 79.—MITRED DOVETAILING.

would be impossible to have the pins show as wide through the side as the width of the board, without leaving a cavity on the inside to mar the appearance of the joint. To remove an interlocking dovetail of this kind, the side must slide off

from the end in a direction of a mitre. This joint is shown together and separated in this manner, in Fig. 78.

This manner of double dovetailing may be carried to the full extent of the thickness of the boards we have to work with, if the inner surface is to be covered by an angle fillet. The principle is carried still further in the next illustrations, Fig. 79. The joint is fitted with a mitre on the edge, and the figure 79 shows the interlocking of two dovetails on the side and one on the end. The dovetails are easily spaced by giving equal quantities for the extreme edge or corner, and an

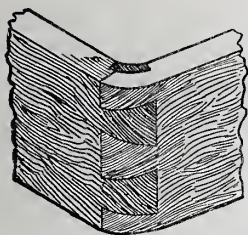


Fig. 80.

ROUND-CORNERED DOVETAILING.

equal amount for the taper of each projection. The work will drive together without trouble except from the splitting of the feathered edges where the sides meet with the ends; it is well to ease them a trifle. This joint is shown separated, on the right in Fig. 79, that its internal construction may be readily

understood, and the thin edges are shown that are likely to be interfered with while the work is being driven together.

This same principle is made use of in the joint shown at Fig. 80, where the corners are rounded with a full quarter of a circle, and a key driven across the inner corner, not only to cover up the enlargements that were made to allow of the interlocking of the parts, but to strengthen and fill in the corner, and to keep the work from splitting. It is well to cover up the keypiece that would injure the appearance of this circular dovetailing. Simple as these examples may appear in the engravings, in the actual work they have proved puzzles for hours, and then it has been declared that nothing

short of a thorough steaming could ever have allowed the parts to come together.

Work of this kind must be carefully laid out if you wish it to come together without trouble. There is no room for the cut and try principle that is so often relied upon in a class of work that is almost experimental. Should one be tempted to try such a principle in dovetailing, it would be well to cut out a sample joint to be sure how the parts go together. Even with a specimen of this kind of work to examine, one cannot always judge correctly the construction from the outside appearances.

Taking advantage of giving exposed parts the appearance of strength and solidity, laying out the work on some apparently interlocking principle, and undercutting those parts that are shut out from view to make space for the connection, what may be considered impossibilities in joints can be made, and challenge examination, as long as the varnish and the polish are not to be disturbed.

An examination of the work shown in Figs. 78 and 79 would show it to be very deceptive in appearance; the end and side are locked together apparently both ways. There is a taper on the end projection that reaches through the thickness of the side, apparently that holds the side from ever being forced out by any strain that may be brought upon it from within the chest. These dovetail-shaped projections are also tapered in the direction of their thickness, and so appear to hold the ends from being drawn off from the sides. Taking these tapers both together, the pieces are completely locked together with a smooth, even joint, on both inside and out, without notches or cavities filled with inlaid work of any kind. But tapering as it may appear, the back face of each end projection and the corresponding notches are not so, and it is the bevel on the back that enables the exposed surfaces

to have an inclination in the direction of both the length and breadth of the parts connected.

The tongue and groove joint shown at Fig. 81 is a very usual method of jointing boards edge to edge. It is not a very strong joint, but it is cheaply made, and matchboarding is joined by this tongue and groove. A bead is almost invariably planed on the edge of the face of the tongued board, so as to give the semblance of a bead to the whole joint, and so disguise it. When shrinkage occurs in the

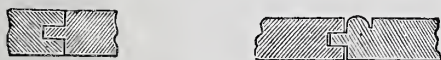


Fig. 81.—TONGUE AND GROOVE JOINTS.

boards so joined the tongue draws out of the groove, and if this shrinkage is not very great, it does not show on the face of the boards. Sometimes the two edges are grooved and a separate piece, called a feather, is used to tongue the two together, and keep their surfaces in a plane. This is a common way of joining floor boards, and a metal strip often serves as a feather. When shrinkage occurs the feather still keeps the joint light-tight.

Rabbeted joints, as shown at Fig. 82, are very easy to make. They require that some other fastening be used to keep the rabbeted pieces together, as they are otherwise quite free to fall apart. In the plain rabbet each board to

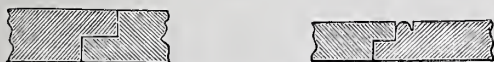


Fig. 82.—RABBETED JOINTS.

be joined has a small portion of its width, usually an amount about equal to half its thickness, planed away with the rabbet plane for half the thickness. Then, if the edges of both boards are straight, the joint is complete. A bead, as shown on the right, is often made to conceal the join, as

explained in the tongue and groove joint. Usually the rabbet is more commonly used for the recess in picture-frames and such things, where the glass or the backing lies.



Fig. 83.
SCARFED JOINT.

Fig. 83 shows a scarfed joint, useful for joining timbers end to end, when it is required to lengthen any wood in

the form of quartering.

The illustration, Fig. 84, shows a method of jointing several boards, which may be useful in some cases, though the tongue and groove, or grooving and feathering is usually

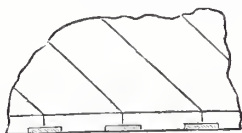


Fig. 84.—RABBET AND FILLET JOINTS.

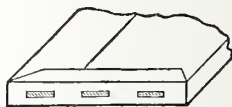


Fig. 85.—CLAMPED JOINT.

preferable, if the thickness of the boards permit. In Fig. 84 each edge of the board has a rabbet planed in it, and a lath of wood called a fillet is laid in the two rabbets, and so forms a connection between the two boards.

A clamp joint is made by grooving a piece of board called the clamp, and tonguing the ends of the boards to fit, thus making the two join at right angles to their fibres. The object of a clamp is to prevent warping, and to give a better edge than the cross-grained boards would afford. The illustration, Fig. 85, shows a clamp mitred at its ends and fitted on to three tenons cut from the boards running end on to the clamp. Most flat surfaces require to have the edges clamped, unless they can be held flat by battens.

When frame-work is put together with ends of stiles and rails projecting beyond their meeting place, joints as shown at Fig. 86 are convenient. The popular "Oxford" frames are so joined at their corners. This joint is made by cutting in each piece a groove the exact width to fit the corresponding piece,

and making the depth of this groove exactly half the thickness of each piece, as shown on the left of the illustration. When



Fig. 86.—NOTCHED AND HALVED JOINTS CROSSING.

the two pieces are brought together they fit, as shown on the right.

Similar to the above is the halved joint, shown at Fig. 87. This is precisely like the notched joint with its projecting



Fig. 87.—HALVED JOINTS.

pieces cut off, and by bevelling the surfaces of the parts that come in contact, as shown at the right, an attempt is made to secure some of the effect of these.

Another form of the halved joint is shown at Fig. 88; it is made by cutting half through each, similar to those already



Fig. 88.—HALVED JOINTS DOVETAILED.

described, but is intended to join a piece projecting on one side only, from the middle of another. The dovetail form holds the piece against a pulling strain, and the form shown on the right gives a very strong joint, and is especially useful

when the corners of the pieces joined are to be chamfered or otherwise cut away. These joints are for constructional work, and are not usually placed in sight. For example, the two joints shown at Fig. 88 would be so fitted that the part shown uppermost would be out of sight in the finished work, whilst the under side could be shown and would appear as a butt joint merely.

Fig. 89 shows four useful joints of various forms for joining wood at right angles. It is not necessary to say much about

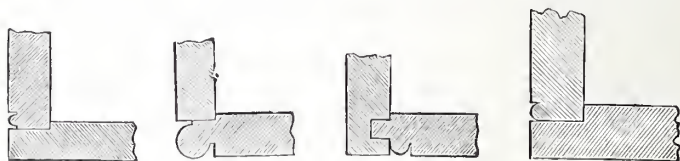


Fig. 89.—VARIOUS USEFUL JOINTS.

the peculiarities of these, as each will be understood as a modification of a form which has been referred to at greater length under its leading type.

The angle joint, shown at Fig. 90, indicates a method of joining two boards which are so placed that they neither form a right angle nor a plane. The tongue and groove joint previously described is here reproduced at an angle of about 135° ; and in the third illustration of Fig. 89 it may be seen at an angle of 90° . The bead planed on the edge of the tongued board effectively conceals the joint, and at the same time forms a pleasing finish to the corner.



Fig. 90.
ANGLE JOINT.



Fig. 91.
LAPPED
MITRE
JOINT.

Fig. 91 shows a lapped mitre joint used for joining at right angles. Nails are used with this joint as shown, and it needs no further explanation.

The mortise and tenon joint is very generally used in all kinds of wood-work, and usually for framing pieces together.

The mortise is a hole, almost always rectangular, cut in one piece, and the tenon is a pin made on the other piece to fit in the mortise. On the left of the illustrations below is shown a double mortise and tenon joint, two mortises being sunk in the lower piece, and two tenons cut on the upper. Tenons are often wedged and glued into the mortises. The right hand part of the above illustration shows a joint in section; the

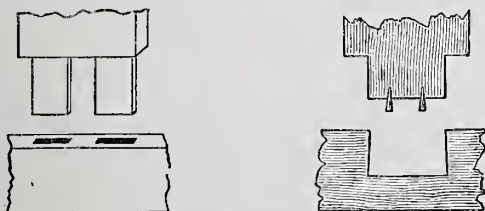


Fig. 92.—MORTISE JOINTS.

mortise is not cut through, but has its ends slightly under-cut. The tenon is made to fit the mouth of the mortise, and is then split at two places, and two small wedges, shown in the wood-cut, are placed in these splits. The tenon is then put in the mortise, generally with plenty of glue, and as it is driven home



Fig. 93.—TABLE OR RULE JOINT.

the wedges come in contact with the bottom of the mortise, and are themselves driven into, and so spread open, the tenon, which thus becomes very firmly fixed owing to the mortise being under-cut, as explained.

The table or rule joint is shown at Fig. 93. This is the form commonly used for table-flaps. The rounded portion is prepared by first planing with a fillister or rabbet, and after

with a special plane known as a table plane. The hollow is planed to fit properly, and the hinge is sunk into both the table-top and the flap, every precaution being taken to ensure the joint of the hinge coming exactly in the centre of the circular hollow and round. The knuckle of the hinge has to be sunk into the table-top, or male portion of the joint, as shown in the illustration, and when the flap or female part is lowered to a right angle with the top, the joint shows a wooden bead all along, as the right-hand figure shows.

Glueing is the general method of fixing together wooden structures that are not to be taken apart. Glue is prepared from waste pieces of skin, horns, hoofs and other animal offal. These are steeped, washed, boiled, strained, melted, re-boiled and cast into cakes, which are then dried. The cohesion of glue is found to be such that if two pieces of board had been well glued together the wood would yield in its substance before the glue. The strongest glue is made from the hides of oxen; that from the bones and sinews is weaker. Good glue should be hard in the cake, a dark colour, almost transparent, free from black or cloudy spots, and with little or no smell. The best sorts are transparent, and a clear amber colour. Inferior kinds are sometimes contaminated with the lime used for removing the hair from the skins of which they are made. The best glue swells considerably (the more the better) when immersed in cold water, but does not dissolve, and returns to its former size when dry. Inferior glue, made from bones, will dissolve almost entirely in cold water.

In melting ordinary glue in the common form of glue-pot, a double vessel containing water, it is an excellent plan to add salt to the water in the outer vessel. It will not boil then until heated considerably above its ordinary boiling point; and the heat is retained longer. Glue loses much of its strength by frequently re-melting, and that which is freshly

made is preferable to that which is re-boiled. Never use any of that old dried-up and burnt glue, which may be generally found in the bottom of a glue-pot kept in a kitchen; have the whole boiled out in a saucepan before putting fresh clean glue into the pot.

Glue may be freed from the foreign animal matter generally in it by softening in cold water and washing several times till it no longer gives out any colour, then bruising it with the hand, and placing it in a linen bag beneath the surface of a large quantity of water at 66° Fahr. The pure glue is retained in the bag, and the soluble impurities pass through. If the softened glue be heated to 122° and filtered, some other impurities will be retained by the filter, and a colourless solution of glue obtained.

To prepare glue for use, break it into small pieces, cover it with cold water, and let it stand for from twelve to twenty-four hours, so that, as already mentioned, it swells to many times its original bulk. The soaked pieces are melted, without more water, over a slow fire and kept simmering for about a quarter of an hour, with frequent stirring. When cooled it is a firm jelly, of such a consistence as very readily to be cut, but too stiff to be tremulous. When wanted to be used, it is merely warmed, which renders it sufficiently fluid to be spread over the surface of the wood with a stiff brush.

A wire stretched across the pot is very useful to remove superfluous glue from the brush; this is much better than pressing it against the edge of the pot, where too much glue is sure to accumulate and burn. The hotter the glue is when applied, the greater will be its power in holding surfaces together; therefore, in all large and long joints, glue should be applied as soon as possible after boiling. Glue will not set in a freezing temperature, the stiffening being prevented by great cold.

When glue is constantly required, as in large workshops, special appliances are used to keep a supply in readiness, and Fig. 94 shows Richards' Improved Steam Glue Oven, which is made with double plates throughout, so that the pots do not come in contact with the steam or water. The steam chamber is cast in one piece, and there is a joint where the flange is bolted on at the bottom. Steam and waste pipes, with screw valves, are fitted on each side, as shown. In front is a

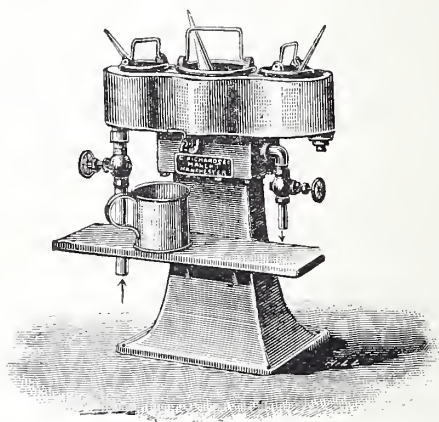


Fig. 94.—STEAM GLUE OVEN.

pet cock, for drawing off the hot water to mix with the glue. There are three galvanised iron pots, which are turned at the flanges, so as to make a tight joint and prevent loss of heat. In the No. 1 size, the central pot, used for melting, holds one gallon, and those at the end $\frac{1}{3}$ gallon each. A galvanised sheet-iron water bucket, to hold 1 gallon, is also included with the ovens. In the No. 2 size all the pots are of the same size, holding each 2 gallons. The floor space occupied by the No. 1 size is 3 ft. by 2 ft., and the No. 2 size 3 ft. by 3 ft. There are a large number of these ovens in use, and they are

strongly recommended by the makers for their cleanliness and safety from leakage.

The strength of a glue-joint largely depends upon the quantity used; those joints hold best in which the wood is brought into closest contact. The following is a brief description of the process of glueing: Have the glue as hot as possible, the glue-pot within easy reach, a basin of hot water, and a bit of sponge on the bench. The surfaces of the wood to be united should be clean, dry, and true; cover quickly with hot glue both the surfaces to be united, and rub them together, pressing out all the glue that can be got rid of; let the motion of one piece on the other be but slight; for instance, in a 3-ft. joint the top piece need never move more than an inch or two beyond the other, which is fixed in the bench-screw; it will be soon felt that they are inclined to stick, then they must be brought at once to that which is to be their final position, and not moved again. If the edges of two long boards have to be glued together, the job will require two hands.

Opinions differ in regard to making edge joints in boards. Some prefer the rub joint just described, both pieces of which are made perfectly straight, rubbed together, and the glue sets without cramps. But others rightly advocate cramped joints, holding that glue is not intended to fill holes larger than the pores of the wood; it is generally held that it is an impossibility to make a perfect glue joint without the aid of pressure. To joint two boards, one having been fixed in the bench-screw, the other is rested against it, so that the edges meet, making a very blunt V trough between them. While one workman steadies this second board (with the help of something on the bench to keep it from slipping), the other, holding the glue pot in his left hand, passes the brush, well loaded with glue, rapidly along the edges; he must not mind

right

spilling his glue ; there is no time now to be careful about wasting a little. When the edges are quite covered, he takes one end of the loose board, his assistant the other, and they rub it up and down a time or two till it sticks, as with shorter pieces. Cramps are then applied and the boards should be brought together as tightly as possible, so that the superfluous glue is squeezed out. The cramp should be unsparingly used for mortise and tenon as well as for edge joints.

Glueing a strip of some choice wood to the edge of a board is called slipping. This is a process that has to be noticed and is best explained by an example. To slip the edge of a pine drawer front to be veneered with mahogany : a piece of mahogany is cut about 1 in. broad and $\frac{1}{2}$ in. or $\frac{3}{8}$ in. thick. It should be as free from warp and bend as possible. It is planed truly on one side, and toothed. The edge of the drawer front is also planed to receive it. This must be planed perfectly straight with a jointer or a trying plane, and toothed also. Then, with the drawer front in the bench lug, the slip of mahogany is wetted with a sponge, and turning its toothed side up, and on a level with the edge of pine front, both receive a coating of glue quickly applied. The slip is turned over on the edge of the front and rubbed firmly backwards and forwards lengthways, two persons being necessary to conduct the operation successfully. The sliding motion is gradually lessened till it stops with the slip in its proper place, when a few rubs with a veneering hammer complete the operation. In most cases a slip thus laid will be found to adhere perfectly in its whole length ; though cramps put on screwed up tight and left for twelve hours are more certain.

Superfluous glue may be wiped off with the sponge when necessary, that is, when it is in an angle or an awkward place to get at afterwards ; but as a general rule, and particularly in a long joint, it should be left on till cold, for it excludes the

air, and goes a long way towards making a good permanent joint.

Ordinary glue readily absorbs moisture, so it is very liable to cause trouble if not protected from damp. Glue may be made waterproof by adding to it bichromate of potash, which should be previously dissolved in water. The strength of common glue for coarse work is increased by the addition of a little powdered chalk. Wood joined by glue requires from one to three days to be perfectly cemented, which is known by the hardness of the portion that remains on the outside of the join, and the force of cohesion of the best glue is such that boards such as commonly used will quite as readily give way to violence at any other part of the substance as at the join.

CHAPTER VII.

VENEERS AND VENEERING.

THE term veneering, as most people know, means covering or overlaying an inferior wood with a costlier one ; the richer wood being cut into very thin sheets with fine saws or knives. For ordinary cabinet making, veneers of oak, mahogany, birch, etc., are usually about $\frac{1}{16}$ in. thick.

Many veneers, however, are cut much thinner ; and across the Atlantic they are cut as thin as wall paper, and used for that purpose. There it is no uncommon thing to see a room having its walls veneered with mahogany, walnut, birdseye maple, or some other choice woods. The fine effect of hard-wood panelling produced by this method will bear comparison in point of cost with ordinary good class wall decorations. Particulars and an interesting packet of sample veneers can be obtained by post on application to the Spurr Co., Boston, Mass., U.S.A.

The veneers for this purpose are cut from logs of choice woods in sheets, about 12 ft. long, and ranging up to some 30 in. wide ; the thickness varying from about 80 to 175 to an inch. When these sheets of beautifully-figured woods are handled the thinness of texture is surprising. The veneers are quite smooth and of even thickness when cut from the log. This is done by a huge, specially-designed machine ; the wood veneer is then mounted on tough paper, the two being cemented together. Thus prepared, the veneer is perfectly supple, and it will neither warp nor split. This

paper-backed veneer can be laid on wood at less cost and with a better result than ordinary veneers.

The paper backing, and the cement by which it is attached to the veneer, are claimed to give several distinct and important advantages. Glueing is effected with less glue, and that used is not brought to the surface of the veneer, where it always causes trouble. This veneer can be laid wet, and consequently is not affected by subsequent dampness. The surface of this veneer is cut so smoothly by the machine that the usual labour of planing and scraping is entirely dispensed with, and the filling and finishing processes are effected with less materials and less labour.

Trees that have had a slow growth in poor dry soil yield the best wood for veneers, being close and firm, and finely figured. The richest veneers are got from the roots of the large trees, which are dug up and often doctored with a view to enriching the figure. They are cut into very thin veneers, and are used for furniture, the best specimens finding their way into the hands of the pianoforte-case makers and fine cabinet makers.

Logs from which veneers are cut are specially treated in a steam or water bath, so as to expand the wood before cutting; the method of steaming the wood sometimes causes it to change colour. The logs are then placed in the machine and sliced into veneers, the thicknesses of which vary with different woods. Some of these slices, cut with the grain, across the grain, and endways, mounted for examination as transparencies, form beautiful and instructive specimens of woods, and illustrate most forcibly the growth and structure of various species of trees.

The veneer-cutting machine resembles a gigantic turning lathe, with a knife ground to a very keen edge running the whole length of the log to be cut. The machine is very

massive, the knife being backed with an iron beam, and the other portions are fixed in an equally solid manner, because the slightest tremor or yielding in any part would tear the veneer and render it useless. The chuck, to which the log to be cut is bolted, consists of a large iron shaft mounted between the centres.

The log having been placed in position, the machine is set in motion. The log revolves against the knife, which pares off the veneer in one continuous sheet at each rotation of the log. So smoothly and easily does the machine work that it is almost impossible to realise the enormous power that is exerted. Apparently, the huge log is cut with as little force as is required to pare an apple. The feed may be gauged to produce a veneer of any thickness, from that of a sheet of tissue paper upwards.

There are two processes of "laying" veneers, termed cauling and hammering. Both are performed with the aid of heat, and may be distinguished as the dry heat and wet heat processes—cauling being the former, and hammering the latter. The first is of greater importance, and should be adopted wherever practicable ; but in certain cases the second is extremely useful.

As has been remarked, all veneering should be done by the cauling process except on those rare occasions when it is not practicable. It is mostly when the cost of cauls and other necessary appliances are altogether out of proportion to the job in hand that hammering is resorted to. This latter process requires so much water applied to the veneer that it is greatly swelled, and, in many cases, in drying it shrinks, leaving open joints, which spoil the work.

In cabinet-makers' shops cauls are adopted. They may be made of wood, the shape and size of the surface to be veneered, or better still, of rolled zinc plate. They are made

very hot in an oven, or before a good blaze of shavings; they are then clamped down on the work when the veneer is got into its place, having been previously soaped or oiled to prevent them sticking to the veneer.

The heat from the caul penetrates the veneer, and re-melts the glue, which chills almost as soon as laid on. The glue thus re-melted, runs evenly over the surface between the veneer and the ground-wood, and when it comes out all round the edges, shows that sufficient heat and pressure have been applied to bring the veneer and ground in close and perfect contact; for the more glue runs out at the edges the more surely will the veneer be properly laid, there being always sufficient left to effect a perfect adhesion of the two woods. The whole is then left to dry and harden.

For laying veneers of small dimensions and on flat surfaces, wood cauls are generally used. To make a caul, take a well-seasoned, straight piece of cedar or pine, rather larger than the surface intended to veneer, and plane it up true on both sides if the work is flat; or, if not, make it the requisite shape, hollow, round, or whatever it may be, to fit the work. The face of the caul is then toothed, and saturated with linseed oil. The oil prevents any glue sticking to the caul. If the caul has to be shaped use thicker stuff, and it is advisable to screw two or three battens on the back. When making shaped cauls it is best at the same time to get out the pieces of wood necessary to form a flat back surface to the work, when it is put in the caul.

To veneer work having a rounded surface on one side and a hollow one on the other: make a hollow caul, to correspond with the rounded surface, having its back flat. Put the round side of the work in the caul, and shape pieces of wood, rounding to fit the back of it. If one side only of the work is shaped these pieces of wood are unnecessary. If the wood is

not wide enough to form the caul, make a good joint, dowel it together, and glue the dowels into one side only, so that it can be taken to pieces for heating. If likely to be much in use the wooden caul should be covered with sheet zinc; cut the metal large enough to cover the face of it, with sufficient to turn over the edges and ends, and fasten it on with flat-headed copper nails. If wooden cauls are used, they should remain not over two hours in the screws, as any glue adhering to the caul makes it difficult to move, and some of the veneer is apt to peel off in the removal. Glue does not adhere to zinc in the same way that it does to wood. Cauls of zinc, $\frac{1}{4}$ in. thick, are better, but very good work may be done with well-oiled pine cauls. Zinc cauls are made both for flat surfaces and for curved, such as hollows, rounds, ogees, and even mouldings.

For veneering large work; cauls of wood may be, and are much used where there are good facilities for heating them, yet cauls made of zinc are much better. These are from $\frac{1}{4}$ in. to $\frac{3}{8}$ in. thick, with smooth surfaces. They absorb heat quickly, and are therefore easily heated. In veneering a large surface it is not necessary to have the zinc caul in one sheet, because it would be very unwieldy, and also it would not be serviceable except for large work. A caul may be in several pieces, for example, two in length and two in breadth; so long as the sheets are all of one thickness, and join closely edge to edge, they serve the purpose as well as a whole caul. Each piece is also serviceable for cauling all kinds of work within its dimensions. Two pieces can be placed end to end to form a long narrow caul, and two placed side to side to form a broad short one.

An important consideration is, that in laying veneers of a soft or porous nature, where the glue is apt to exude through to the caul, it does not stick to the zinc; so that zinc cauls are removed with freedom. Wooden ones very often adhere

to the veneer from the glue having exuded, and sometimes it is impossible to remove them without lifting away portions of the veneer, and thus seriously damaging the job ; in the case of root walnut and other veneers of a like nature, it is very unsafe to attempt laying them with cauls of wood.

To veneer large flat surfaces, such as plain panels, wardrobe ends, sideboard tops, etc., by the cauling process, other and somewhat costly appliances are preferable, and various devices have been tried to communicate the desired amount of heat expeditiously. A steam chest is one of these. This is a large iron table, the top of which is truly planed in the form of a shallow box, into which a jet of steam is allowed to pass, and the work to be veneered placed upon the table, veneer downwards ; then cross-bars are brought down with a strong pressure. The heat in the iron penetrates the veneer and melts the glue. This contrivance is of use only where steam is at hand.

Commencing with the preparation of the groundwork to be veneered : a suitable wood requires to be thoroughly well seasoned, free from knots and shakes, and should not contain turpentine. The most even woods should be chosen, such as common cedar or yellow-pine ; some of the best for the purpose is "arrow board," 12-ft. lengths of which can be had of perfectly straight grain, also Bay mahogany and American walnut, although good pine answers well for ordinary purposes—hard wood can be veneered, boxwood with ivory, for instance ; but wood that will warp and twist, such as knotty and cross-grained mahogany, must be avoided.

The surface, if flat, is carefully planed-up with the trying plane. It is then well toothed over with the toothing plane—first the lengthways of the grain of the wood, and afterwards crossways—care being taken to tooth the work thoroughly. If working pine, use a coarse toothing-iron ; if mahogany or

other hard wood, use a fine iron. If the work has a hollow or a rounded surface, it is shaped with suitable planes, rasps, and files; and finally well papered crossways with coarse glass-paper. Sizing is the next operation. To make size, take one part of good Scotch glue and boil it well with 50 parts of water; then brush over the groundwork while hot; allow to dry, and if there should be any defects in the groundwork, fill in with stopping. Make stopping by mixing some finely-ground plaster-of-paris with hot glue and water, enough to form a moderately stiff paste. Then lay in where necessary with a chisel, taking care to allow for shrinkage; let it dry, then level off with a rasp. When veneering framed work the rule holds good in all cases—avoid having end-wood and side-wood in the same veneering surface, as the two do not shrink alike. The end-wood practically does not shrink at all; consequently in a short time any such portion covered by veneer is at once apparent, as it stands above the surrounding surface. There may be cases in which this cannot be avoided, but in most cases it can, and it always should be guarded against.

Most veneer, such as mahogany, oak, chestnut, maple, sycamore, birch, satinwood, and various other woods, are ready for cutting as received from the merchant. Showy, but not the most durable veneers, are those known as curls. These are short cuts of the log, taken from a part where a limb forms a fork in the tree, having a strong feathery-like figure diverging from the centre. They are usually about 2 ft. long, and the practice is to take two sheets and reverse the ends for joining, they being marked, when sawing, for this purpose. A drawer front veneered with curls has consequently a butt joint in the centre, the spreading ends of the pieces being carefully jointed, so that the same figure or marks in the veneer will appear going both ways from this

centre joint. These veneers are very showy, but they are very apt, after a time, to get full of cracks, and with age they get very dark in colour.

Some veneers, as burl walnut, brown oak, amboyna, &c., present an uneven curly surface called buckly. When this is the case damp one side with clean water, lay it down with its dry side upwards, and put the wet side of the next veneer upon it, repeating the operation till all the sheets are piled up. Take care to keep each veneer, if more than three or four, in its proper order as damped and turned over, and do not get them mixed. Let stand about five or six hours; then spread out, and allow to nearly dry, and the veneer will be ready for cutting out. Look carefully at the wood before cutting it, and see that you do so in such a manner as to get the grain to the best advantage. Cut it rather larger than the surface to be veneered, to allow for levelling at the ends and sides.

Veneers for drawer fronts are bought in sets of five or six. They are consecutive cuts and are all of one figure, being numbered by the sawyers, and, care being taken to place them on the fronts all in the same way, the various markings will appear almost alike in the whole fronts.

These veneers may be so narrow that they will not entirely cover the wider drawers, in which case a piece has to be added to the breadth; the joint thus made is easily concealed beneath one of the mouldings planted on the face of the wide drawer.

Veneers of the feathery curl sort, two pieces to each drawer front, must have the butt joint exactly in the centre of each, passing through the centre of the keyhole. To make this joint properly, the whole of the veneers are placed together exactly as they were when in the solid log, and held together by two pieces of board and two hand-screws. The ends to

be jointed are squared across, and cut with a dovetail saw all together, and afterwards planed with an iron plane. Then, being taken separately, each pair are carefully fitted together. This done, they are laid on a flat board with the joint placed close, and a few tacks driven in at the edges to keep it so. A piece of thin calico, about 2 in. broad, is glued along the joint. When this is dry, the veneers may be laid as one piece.

To flatten damp veneers, get two pieces of board, dry straight pine will answer well, rather larger than the veneer, and heat them on a stove or before a bright fire; then place the veneers between them, hand-screw together, and allow to remain for about half an hour; repeat this operation until the veneer is dry and thoroughly flat.

The veneer is now ready for repairing; if it is perfectly sound, this is unnecessary; but it frequently happens, especially with burls, that it has holes, which require filling. Take a piece of the edge of the veneer. Select the part of it which matches best with the grain of the wood around the hole required to be filled in. Place this piece under the hole. A cutting-stamp, rather larger than the hole, may now cut it square or circular, and the piece for filling it at the same time; or with an ordinary pocket-knife, having a sharp point, cut the hole and veneer the required shape. After filling in the veneer, lay it on a flat board; then press the pieces in with a hammer. If they are large, use one or two fine-pointed tacks to keep them in position. Now cover all pieces with strips of paper; select a strong paper for the purpose but one that is not thick—copy-book or old note-paper answers well for the purpose. Glue it one side, taking care to use the glue thick enough to hold the wood in position. Pay particular attention to this, or it will cause a good deal of trouble. It is best to cut the paper in strips about $1\frac{1}{4}$ in. or $1\frac{1}{2}$ in. wide.

Lay it on a board to glue, and smooth it over the veneer with a damp rag.

Now proceed to jointing. Place the veneer in the position it will occupy when laid. Observe that it matches. That is to say, if one joint with two veneers, or two joints with four veneers, see that the grain of the veneers forms a symmetrical figure. If the veneers have been kept in their right or following order, this will not be difficult. If working a thick saw-cut veneer, make the joints with an iron plane or ordinary trying plane on the shooting board; if using a thin knife-cut veneer, make them with a knife and straight-edge. Now put the jointed edges together on a deal board. Tack one edge down, put the tacks about $\frac{3}{4}$ in. from the jointed edge, and about $2\frac{1}{2}$ in. apart. Having tacked one piece down, put the other close up to it, and tack in the same manner. Now cover all the joints with paper, glue in the same manner as previously mentioned for the repairing, smooth it well down with a damp rag, and allow to dry. If the weather is hot, it is best to cover the joints, to prevent them from drying too quickly. A good and simple method is to lay the board with the veneer downwards on the floor. Let the joints dry, then take out the tacks, and knock the tack holes up with hammer from the underneath side; put the veneer aside until ready for laying it. It is best to cover it and keep the air from it, by placing it under a board.

Preparatory to laying, the veneer, and the ground-wood on which it is to be laid, must both be carefully prepared: the former, if sawn, by taking out all marks of the saw on both sides with a fine toothing plane, the latter with a coarser toothing plane. If the veneer happen to be broken in doing this, it may be repaired at once with a bit of stiff paper glued upon it on the upper side. In all cases the veneer should be toothed on the gluing side before laying. The wood to be

veneered must now be sized with thin glue ; the ordinary glue pot will supply this by dipping the brush first into the glue, then into the boiling water in the outer vessel. This size must be allowed to dry before the veneer is laid.

Having made the caul and prepared the glue, get the hand-screws and cramps ready and commence laying. Heat the caul on a stove or before a bright fire, if it is dowed together, and if it is more convenient, take it to pieces, taking care to first mark the joints. If laying two similar pieces of veneer on a flat surface, heat both sides of it, and do both of them together. If not, get one side of the ground wood as hot as can be, without letting it burn. While it is heating, set the hand-screws and cramps open to near the distance required, and place handy to your work. They should be free from old hard glue, which would mark the work.

Pressure is applied to cauls with the hand-screws already described on p. 27. If the caul be from 3 in. to 5 in. broad, such as for door stiles, the screws would be put on with the jaws reaching quite across, one on each side alternately, and at intervals of about 6 in. If the caul be, say, 10 in. broad, the screws would be put on reaching to the centre in pairs from opposite sides, and at intervals of about 6 in. In applying the hand-screws to work of this kind, it is to be observed that the whole length of the jaws must bear equally on the breadth of surface pressed between them, as if they press only at the point, or at the heel, they are comparatively ineffective. The hand-screws are first put on near the centre of the caul, and finish at the ends, the glue being thus carried along from the centre, and flowing out at the ends and sides. The hand-screws should be placed about 6 in. apart, and they must bite fairly ; not one screwed tighter than another. If the work is so wide that the screws will not reach its centre either from the sides or ends, get two pieces of wood 2 in. or $2\frac{1}{2}$ in. square,

plane them up straight on two opposite sides, put them one over the other on the work, and hand-screw them at each end; put a piece of packing between them in the centre, and they will then tighten in the middle and give an even pressure.

An effective tool for applying the pressure in place of hand-screws when veneering large surfaces, is the frame shown at Fig. 95. This is a rectangular frame, strongly made of hard

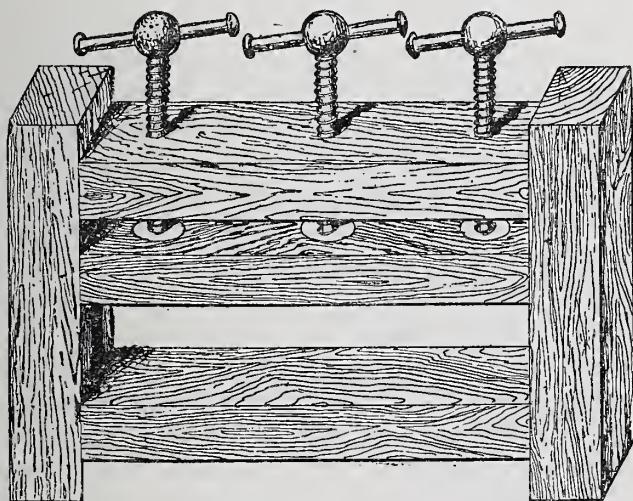


Fig. 95.—VENEERING FRAME.

wood; it is easily made by a cabinet worker. The upright posts may be $3\frac{1}{2}$ in. square, and the upper and lower rails let into them $3\frac{1}{2}$ in. by 3 in. Between these rails is a clear space of 10 in.; and in this space a bar is fitted to rise and fall by means of the three screws. This movable bar is 3 in. by $2\frac{1}{2}$ in. thick, and is slightly curved on the under side, so that the pressure is applied first by tightening the centre screw, and then the outer ones, which have the effect of curving the bar on the upper side, and making the whole of the under side

bear equally on the caul. The screws in this frame are iron, square threaded, and may be $\frac{7}{8}$ in. or 1 in. diameter. They have nuts with two ears; these are screwed to the under side of the top rail in the frame. The centre screw only is made to lift the movable bar by means of a collar and plate; the outer ones simply press upon small iron plates in the back of the bar. The frame admits a board, say 24 in. wide, and to veneer a length of, say 6 ft., ten frames would be necessary.

When quite ready with cauls and cramps, &c., glue the ground-wood well, and if the veneer shows any inclination to be buckly, glue it slightly on the under side, as this will help to soften it; any jointing paper on the veneer was laid on the topside. Having finished gluing, put the veneer on the work, and smooth it gently over with the hand. Then see that the caul is hot enough, and its surface free from any dirt; rub it over with a greasy rag, and lay it gently on the veneer. Draw the work and caul a little over the front or end of the bench, just far enough to get one handscrew or a frame on; put it on gently at first, then tighten; stand the work on the floor and rest it against the bench while putting on the other hand-screws. Let the caul remain on for an hour, in very hot weather, longer; then undo the hand-screws, and if the caul sticks to the work, insert the blade of a wide chisel between the caul and the veneer, and carefully get them apart. If the glue was thick enough and the caul greased well, there will not be much trouble, and by giving the end of the caul a tap with the hammer or on the bench, it can be easily got off.

Examine the veneer, feel it all over with the hand to see that it is down. If it is up you will tell by the hollow sound on tapping it, as well as by the raised blisters that will show. But there will be no trouble if the caul is heated sufficiently, the glue used thick enough, and the hand-screws put on properly. Should there be any blisters, let the work stand about

one or two hours, and then put a smaller hot caul on where required until the veneer is well down all over.

No attempt must be made at scraping, sandpapering, or polishing veneered work till the glue is perfectly dry and hard. It should be left in a warm room twenty-four hours at least, and better still if left two or three times as long. The surfaces of sawn veneers are always planed first with a high-pitched hand plane, set very close, then scraped and sandpapered. Knife-cut veneers often only require papering.

When veneering several similar articles, such as a set of drawer fronts, for a chest of drawers, it is usual to veneer two of them at one time, the caul being heated on both sides. The hand-screws require to be large, with long jaws. Help must be obtained to heat the caul, while glue is applied copiously to the drawer fronts. The veneers having been previously toothed on the gluing side and marked, they are laid upon the glued front and are rubbed all over with the hands. They should project over the front $\frac{1}{4}$ in. or so all round. At the places to be afterwards bored for the knobs, two tacks are driven through the veneer into the front to prevent them slipping under the hot caul while the hand-screws are being applied. Six large hand-screws for the front or inside, and six smaller for the back, are necessary to lay veneers on two fronts. Those that go inside the drawers should go quite to the bottom, so that the jaws require to be at least

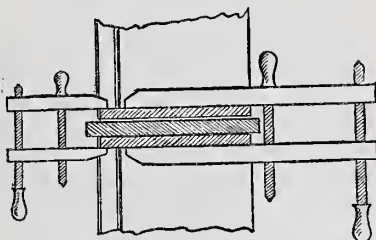


Fig. 96.—VENEERING DRAWER FRONTS.

8 in. long. The diagram, Fig. 96, will give a clear idea of this part of the work. It shows the two fronts with the caul and veneers between, and the hand-screws as applied.

Suppose we have to veneer the two ends of a wardrobe, 6 ft. long by 21 in. broad. We should have ten of the frames shown at Fig. 95, and a zinc caul in four pieces. Place a piece of board upon trestles, and on this board arrange the ten frames in a row, and about 8 in. apart, and with the movable bars all raised. Have the two wardrobe ends each planed an equal thickness; the side to be veneered, which should be the heart side, is well toothed and sized all over with thin glue. This sizing, after being thoroughly dry, is again toothed lightly to remove any lumpiness in the size. The veneers are cut a little larger all round than the surface to be covered, and afterwards marked with a pencil to show how they are to be laid when glueing. This laying must be done with as much speed as possible, but a mistake in the hurry of placing the veneer is irreparable. The veneer being marked, it is toothed on the glueing side. The grounds and the veneers are swept clean of dust, and the former placed edge to edge. A pot of boiling glue, not very thick, is now brought, and the grounds are rapidly coated all over with the glue. Two persons, with a brush each, should do this, and place the veneers in their position before the glue chills, while the cauls are heating on both sides. One of the wardrobe ends, with its veneer-side upwards, is slipped within the frames. The cauls, which are hot quite through, are now placed upon this veneer, edge to edge, then the other end is placed in the frames, with its veneer towards the caul, and all being carefully adjusted, the moving bars are lowered by the centre screw in each of the ten frames, beginning with the centre frames and finishing with the end ones; then going back to the centre frames, the end screws are brought down; thus the glue is made to flow from the centre towards the edges. After the glue has begun to flow, the whole of the screws may be gone over again, beginning with the centre ones, as before, and giving each a little more

pressure. In three or four hours the work may be removed from the frames. All this should be done in a warm room, or workshop free from cold draughts, as a whiff of cold air chills the glue in a moment.

The method of veneering the base of a chest of drawers in the proper, though not the usual, fashion will now be described—having the grain of the veneer running in the same direction as the grain of the groundwork. This method of veneering is much more difficult than that of banding with scraps of veneer, but it is a much better manner of doing it. This is the method of correctly making a piece of furniture, if veneering of any sort is allowed to be called correct work. The groundwork of the base is made by framing together and two semi-circular blocks are made and sized for veneering in the same manner also. The face of the base is covered with veneer, except at the two ends where the blocks are to be placed. This veneer should be laid with a caul—when properly hard it is planed and finished with sandpaper; then the two blocks are fitted exactly in their places against the ends of the front veneer, and they are glued down without being previously veneered.

The method of veneering the blocks and base ends with one piece of veneer is shown in Fig. 97. A yellow-pine caul is made the length of the base end, not including the semi-circular blocks; then a piece of No. 12 zinc is procured, long enough to reach from the small block of wood at the inner edge of the circular block, round the block itself, along the base end, and round the ends of the caul, as indicated by the double line in the cut. The caul should be 6 in. broad, and the zinc fixed on with tacks along the edges.

A piece of veneer has now to be cut long enough to go round the block and along the base end, with a little margin both in length and breadth. The portion that goes round the

block must be well toothed, and also scraped on the outside, before putting on. This is to thin it somewhat, as it has to be bent round the block; next glue a thin piece of cotton cloth on the scraped side of the veneer. This is to prevent it splitting across the grain of the wood while bending. A cut is made with a dovetail saw, close to the inner edge of the block, about $\frac{1}{4}$ in. deep in the face of the base. The end of the veneer is now squared, and fitted into this cut.

Reference to Fig. 97, shows a cramp and five hand-screws brought into use. There are really ten hand-screws, another

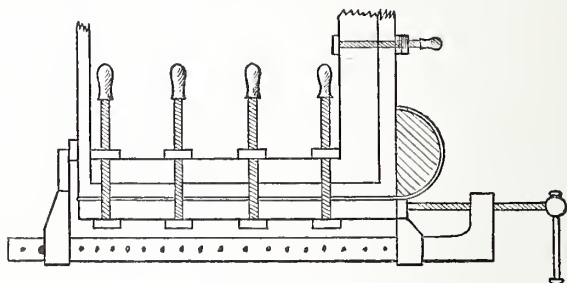


Fig. 97.—VENEERING BASE AND END.

five being placed exactly opposite those shown in the drawing. All being in readiness, the zinc caul is to be well heated, and a copious supply of glue applied to the groundwork to be veneered; also a thin coat to the veneer, the end of which is fitted into the saw-cut above mentioned.

The hot caul is applied by placing the end with the block close to the circular block, and applying two hand-screws. Then the zinc, with the veneer, is bent gently round the block, and when laid along the base end several hand-screws are applied, and lastly the cramp, using a small block of wood at the back to keep the jaw clear of the caul end. The exposed portion of the zinc round the block, which cools very quickly, must be heated with a smoothing iron and more

pressure applied to the cramp, when the glue should run out at the edges. The hand-screws are then tightened up, when, if managed properly, the veneer will be lying perfectly close. This caul should stay on for at least ten or twelve hours, when the same operation may be performed with the other end of the base.

We must now notice the process of veneering curved surfaces, commencing with a simple convex. By wetting well one side of the veneer it will curl up, and can easily be laid on such a surface ; but it will be well to bind the whole round with some soft string to assist it in keeping down while drying.

Fig. 98 is a tool with which forms having one curve may be

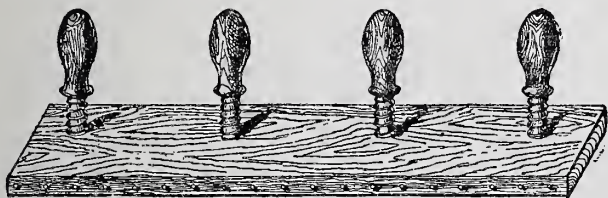


Fig. 98.—TOOL FOR CURVED VENEERING.

veneered by the wet, or hammering, process. It consists of a board of hard wood, a little longer, and not quite so broad as the work to be veneered. Through the centre of this piece a series of wood screws pass at intervals of six or seven inches, as shown. A piece of stout canvas is tacked to the hard wood, so as to form a bag with open ends. To veneer a surface which is a semi-circle in section, the ground, with the veneer on it, would be placed in the canvas bag, the flat back of the work being parallel to the board above it, and the veneer next the canvas. The screws are now brought to bear upon the back of the work, which tightens the canvas, and forces the veneer close to the ground. The canvas is now well saturated with hot water, and held to the fire, all the screws

receiving an occasional turn. The glue now runs out at the ends, the canvas is rubbed all round with the veneering hammer, and a little more pressure applied to the screws; then it is laid aside for twenty-four hours to dry. This is a very simple, effective, and expeditious method of veneering many of the forms used in cabinet work. As the canvas accommodates itself to the form placed in it, it matters not whether the form is circular or elliptic, or a combination of both, and it will veneer anything, from a little over a semi-circle or semi-ellipse down to the smallest arc of either. Several boards, with canvas of a width to suit various requirements, are useful, and the screws may be made interchangeable.

A more complex form is Fig. 99, a section of an ogee drawer front of pine, to be veneered with, say, mahogany.



Fig. 99.
VENEERING
AN OGEE.

The ground is moulded with casement planes to the required form, taking care that it has the same sectional form its entire length. The hollow part is roughened with a rasp, and the round part toothed; then it is glue-sized. A caul has now to be made to fit every part of this ogee; this caul is represented in Fig. 99, and is an exact reverse of the ogee. This caul

may be saturated with oil, or, what is much better, it may be covered with a sheet of No. 12 zinc, made to assume the proper curvature; it is tacked lightly to the wood at the edges. Before applying, the veneer must be made to assume the ogee form. To cause this, mark the veneer as it is to lie; then take a sponge and hot water and wet the veneer on the outside the whole length and but half the breadth; then turn it over and wet the remaining half on the opposite side, and it will assume the double curved ogee form.

Now the caul is made very hot, the ground is copiously

glued, and the veneer laid on. To prevent it shifting, a tack is usually driven through it at each end into the ground, which is generally a little longer than required in the finished job. A piece of thin cloth is first placed over the veneer, and then the hot caul, which is pressed down with the hand-screws, those about the centre being tightened first.

As already mentioned, the method of veneering by hammer is useful in certain cases. Sometimes to veneer an edge, or put a narrow slip of veneer on some small surface where it would be very inconvenient to caul it down.

Throughout the hammering process never have any slop and wet about the work that can be avoided. Whenever using the sponge, squeeze it well first. Damp and heat is wanted, not wet and heat. It is a good thing to have the sponge in the left hand nearly all the time, ready to take up any moisture or squeezed-out glue from the front of the hammer, which, though a valuable tool for the amateur, is not much used.

Suppose that the veneering by hammer is about to commence. The glue in good condition, and boiling hot, the bench cleared, a basin of hot water with the veneering hammer and a sponge in it, a cloth or two, and everything placed in such position that one will not interfere with, or be in the way of, another. Damp with hot water the outside of the veneer, then glue the other side and glue over as quickly as possible the wood ground. Then bring the veneer to it, press it down with the hands, and take care that the edges of the veneer overlap a little all round. Now grasp the veneering hammer close to the pene, shake off the hot water, and, with the handle pointing away, press down the veneer and squeeze the glue from the centre out at the edges. If a large piece of stuff is to be veneered, the assistance of a hot flat iron, or the inner vessel of the glue pot itself, which often

answers the purpose, will be useful to make the glue liquid after it has set; but don't let it dry the wood underneath it, as it may burn the glue and scorch the veneer and ruin the work. Having got out all the glue possible, search the surface for blisters, which will at once be betrayed by the sound they give when tapped with the handle of the hammer; heat must be applied, and the process with the hammer repeated. When the hammer is not in the hand, it should be in the hot water. The whole may be sponged over with hot water, and wiped as dry as can be.

To veneer the ends of the wardrobe already described, by the hammering process, the two are prepared as before, but they are veneered one at a time; so we will describe the process with one only. The end is placed upon the bench, veneering-side up, the veneer toothed as before and placed upon it toothed-side down. The glue must be boiling and the room very warm, and two ordinary laundry smoothing irons are kept very hot on a stove. All things being ready, dip a sponge in the hot water, and wet the upper side of the veneer all over, and lay it aside. Coat the ground work freely with the hot glue, beginning at the centre and coating one-half of the surface only. Now place the veneer carefully in its place, and rap it smartly all over the glued half with the veneering hammer.

Begin in the centre, which is the extremity of the glued part, and with the sponge give it a copious supply of the hot water; then with the hot iron iron it rapidly, the portion ironed each time being about 1 ft. broad, and entirely across, which gives about two square feet of surface to be gone over with the hammer. The iron must not be allowed to rest for an instant on the veneer, or it may stick and lift a piece out—a few rapid strokes, adding more water wherever a portion appears dry. Now apply the hammer, which is held with the

handle in one hand, the other pressing upon the head ; give the handle a motion from side to side, at the same time pushing forward, when the hammer describes the zigzag course as indicated in Fig. 100, carrying the glue in front of it. When the ironed portion has thus been gone over, the glue should run out at the edges. Now a few rubs are given to it with the hammer, giving long instead of zigzag strokes. In order to find if it is lying solid, it is tapped lightly all over with the handle of the hammer. By this means the smallest blister will be detected. When a blister is detected, it may at once be laid by a little more rubbing, but, if obstinate, a little bit of paper placed over it with a piece of wood and a weight over all will be effective in most cases. A thick body of glue is lying just where the rubbing left off. Again apply the water and iron, doing a portion quite across as before, taking care to reach, but not to go over, the portion already finished. Again rub, always taking care that the glue carried before the hammer is being taken from the portion already finished. In this way the rubbing and ironing are continued till the end of the glued half is reached.

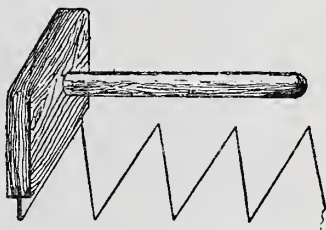


Fig. 100.—USING THE VENEERING HAMMER.

To glue the other half, turn the veneer up and apply the glue to the ground, covering all the surface not previously glued ; rub down the veneer as before, and begin sponging and ironing in the centre, just where the first portion was finished, and cause the glue to travel away towards the end. A surface of this area will thus require six or seven ironings. If the glue runs out freely all round, the heating has been sufficient, and, if free from blister, the work may be said to be satis-

factory. The two ends thus veneered may be placed face to face with sheets of newspaper between, and a few small hand-screws fixed on them ; thus they must stand for 24 hours or so, before any attempt is made to plane the veneer, as, having imbibed much water in laying, it takes long to dry. Veneers laid with a caul may be cleaned in half that time.

Lay the work veneer-side downwards on the bench, and scrape off the glue that has come over the edges. Now fix it in bench-screw, and level with a paring chisel if thin veneer, use a smoothing plane if thick. Put the work aside to dry. If two pieces the same size, put them with their veneered sides together ; if only one, place it so that the air does not get at the veneer. Allow to stand two or three days, then with a chisel scrape off the paper used for filling in pieces and jointing, having previously damped it with hot water. The work is now ready for sizing ; this operation may be dispensed with, but it is decidedly advantageous, especially if working wood having an open grain. The size, which should be about the same strength as that used for groundwork, is brushed or rubbed well over the veneer, then wiped off as dry as possible with a cloth.

It is a great advantage to allow work to stand a long time after veneering, before cleaning off. If done soon after laying, it will present an uneven, irregular surface when polished, because the glue used has not had sufficient time to thoroughly dry and shrink. The time varies in different cases. Some pianoforte manufacturers allow as long as three months, but in ordinary work this is impossible. From six to ten days is a very fair time, although, in good drying weather, work cleaned off three days after veneering, may look very well. To clean off, first tooth over with a fine iron, then plane with an iron plane, and scrape with a steel scraper. Now paper with a cork and middle 2 glasspaper, then with fine 2, No. 1 $\frac{1}{2}$, and 1.

If the grain of the wood is open, or has a tendency to rise or bristle up when polished, like oak or black walnut, it is best, after getting as far in the process as the papering with fine 2, to damp with clean water, and allow to dry. This will raise the grain. Finish the papering, and the additional trouble will be amply rewarded for by the smoothness of its appearance.

Veneered surfaces are finally French-polished or treated in some similar way. This process of polishing is a trade apart from cabinet work proper.

CHAPTER VIII.

SIMPLE EXAMPLES OF WORK.

 FEW simple articles will now be illustrated, and the process of making each one minutely described. The reader who has acquainted himself with the contents of the preceding chapters, should find no difficulty in understanding what follows. Each tool that is mentioned in this chapter has been previously described, and with the processes it is generally the same ; any new process is described with sufficient minuteness to enable any one understanding the prior instructions to carry it out.

Examples of work might be extended to fill many volumes, but, after the rudimentary processes have been once thoroughly mastered, the construction of cabinet work becomes only the proper application of these processes.

The importance of making drawings of all work of constructional character cannot be over-estimated. The time taken to make a sketch is invariably saved over and over again in the extra speed made with the actual work. Often a rough sketch, with the principal dimensions marked in, is all-sufficient for working to, but however rough the sketch may be it should be complete. Recollect that alterations can be made to a drawing without waste of costly material, while alterations in construction often necessitate the rejection of partially-prepared materials. With a drawing we know what we are aiming to accomplish, but without it we are generally working, to a great extent, in the dark on a cut-and-try principle

which is likely to produce successful results more through accident than design.

We will commence with the wooden stool, shown at Fig. 101. A stool of this sort, when thoroughly well made, as here directed, is almost everlasting. It may be painted according to fancy, or left white and kept clean. Regarding this simple article, it may be remarked that, from its apparent insignificance, many practical men affect to despise it as unworthy of description, yet to judge from the way in which these little buffet stools are usually made, is it not a fact that very few makers really know how to construct it as it ought to be made? and the same question holds good with other articles that are

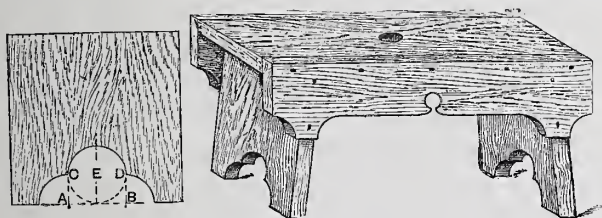


Fig. 101.—WOODEN STOOL.

considered beneath the notice of the expert, and are therefore generally left for young beginners to make after their own fashion.

The following is a good way to make a buffet stool of any size. There may be other ways equally good; certainly, there are many not so. We will describe a medium size. Select a piece of pine-wood to make a top 20 in. long, 10 in. broad, and $\frac{7}{8}$ in. thick. Plane both sides smooth and level; mark the best side for the upper; square the two ends, and plane the edge till the top has an equal breadth of 10 in. Next plane and square two pieces for the feet, each $10\frac{1}{2}$ in. square, and same thickness as top. After this, two sides 20 in. by 5 in. by $\frac{5}{8}$ in. thick. Mark the feet and sides, best sides out.

It will be noticed that the feet are spread out at the bottom. Each foot has a spread outwards of one inch ; consequently the upper ends of the feet must be bevelled a little in the squaring across. Make two grooves in the under side of top to receive the feet. These grooves are $\frac{1}{4}$ in. deep, and a shade less in width than the thickness of the feet, so that the latter may be fitted neatly into them.

The feet shown in the illustration are to be cut out at bottom. To do this, divide their breadth into equal parts, as in Fig. 101. Set compasses to one-sixth this breadth, and draw a circle from *e* as centre ; draw lines from *c* and *d* to the bottom, and from *a* and *b* as centres draw quarter circles with the compasses still set same distance. Fix the two feet together and cut out with bow saw all the wood within the outer lines thus obtained, as shown. Smooth the edges with a small spokeshave, and sandpaper. Fit the feet tightly into the grooves of the top ; then plane both sides smooth, when they will be ready for glueing and nailing. With a bradawl bore through the top two holes in the centre of each groove ; put a little glue in the grooves, insert the feet, allowing their extra breadth to project beyond the edge of the top equally, which will be $\frac{1}{4}$ in. on each side. By using the bevel see that both feet have the same spread ; drive to the bottom of the grooves ; then drive four 2 in. cut nails through the top into each foot.

The two sides have to be fitted on next ; their dimensions have been given ; square their ends same length as top. To groove them to receive the edges of the feet, turn the stool edgeways upon each side, and draw for the grooves with the marking awl. The depth of this groove is $\frac{1}{4}$ in., exactly what the foot projects beyond the top. Mark the sides when drawing, so that you will know how to replace them. To shape the sides, set compasses to $1\frac{1}{2}$ in. Draw a quarter

circle in each corner, which will reach to $\frac{1}{2}$ in. from the groove for foot. Draw another quarter circle within the foot, keeping it the same distance from the groove. Continue the curves along the central portion of the side with a straight line, find the centre of the length, and bore $\frac{1}{2}$ in. hole with centre bit, 1 in. from the edge. Now curve the edge into this hole with compasses set to 1 in. Having thus drawn one side, place both together in bench vice and fix with the addition of two hand-screws. Saw out, and finish up the edges with sandpaper before separating. Bore them for nails, five along the upper edge to nail to top, and two through each groove to nail to the feet. Nail with $1\frac{1}{2}$ in. cut nails. Punch all the nails a little below the surface. Before nailing on these sides a little thin glue is put into the grooves, and also along the edge of the top. Clean the stool off with smoothing plane, then sandpaper all round, slightly rounding all edges and corners. Find the centre of the top and bore a $1\frac{1}{4}$ in. hole with a centre bit. Take the rough edges off this; level the feet by standing the stool on a flat board, and it is finished.

We will now take in hand a bracket shelf for fixing to wall, such as is commonly used to support a timepiece, a few books, or an ornament. It may be made of pine, walnut, mahogany, oak, or any other wood that suits the fancy. This shelf is fixed to the wall with two brass plates, such as are used to fix wall mirrors. If made in pine, it may be painted or varnished to taste; if of any of the hard woods it should be French-polished.

Fig. 102 shows the design, and a medium-size for the shelf is 20 in. by 6 in. by $\frac{5}{8}$ in. thick for the top, the two front corners rounded, and with a hollow or "cavetto" moulding on the lower edge. Two pieces for the brackets, $\frac{5}{8}$ in. thick, are made of the form shown in the end view, and are placed under the shelf 3 in. from the ends. A portion is

cut out of the back of these to receive a rail, 2 in. broad, and $\frac{5}{8}$ in. thick, let in flush, and shaped at the ends as in Fig. 102. Two short drops, turned, or worked square according to fancy, are placed under the shelf, as shown, against the brackets. Another rail $1\frac{1}{2}$ in. broad is fitted between these drops, and is pierced with the openings as shown in the front view, each opening being four holes bored with $\frac{1}{2}$ in. centre bit, running into each other and forming quatrefoil.

The next work will be a little more ambitious than the last, as shown by Fig. 103, which represents the front, side, and plan views of a wall book-case or what-not. This may be

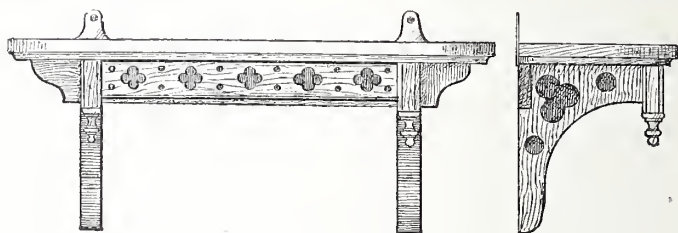


Fig. 102.—BRACKET SHELF.

used as shelving for books, ornaments, or other articles, as the owner may need. It is very useful and may be made ornamental also, and its construction is exceedingly simple. It is well adapted for small rooms, as it hangs on the wall, taking no floor space. It is fixed to the wall with screws if placed against a wooden partition, or hung up on two strong nails driven into the wall.

The hanging what-not, shown at Fig. 103, may be made in pine, stained and polished, or in mahogany or other wood to harmonise or contrast with the furniture. That is, it may be made in any suitable wood, as the maker may fancy. It is a series of four shelves alike in size, the shape shown in the plan, and the dimensions may be altered to suit.

These shelves are 3 ft. long, 10 in. wide in the centre, and $\frac{7}{8}$ in. thick. They are supported by two upright back straps, $2\frac{1}{2}$ in. broad and $\frac{7}{8}$ in. thick. These are stop-chamfered between the shelves, and shaped at the ends, as shown. The shelves are let into grooves in these straps about $\frac{1}{4}$ in., and

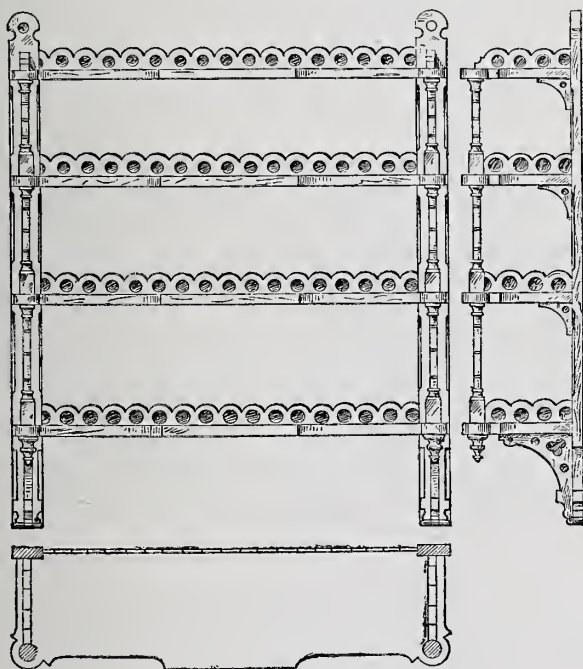


Fig. 103.—HANGING WHAT-NOT.

screwed from behind are small brackets, shown under the three upper shelves. The six pillars are turned throughout, $1\frac{1}{2}$ in. thick at base and cap, and have tenons to fit into round holes in the circular corners of the shelves. Under the lowest shelf are two brackets. On each shelf, behind the pillars, are fence rails with their ends let into the base of the front pillar,

except on the top shelf, and the opposite ends into the back straps. A similar fence runs along the back of each shelf. These are to prevent the books or other articles touching the wall, as the case has no back. These back fences are nailed to the back edges of the shelves; they help to prevent the shelves bending when weighty articles are placed on them. The fences are 2 in. high, and are cut on the upper edges into semicircles of 2 in. diameter, a $\frac{7}{8}$ in. hole being bored through

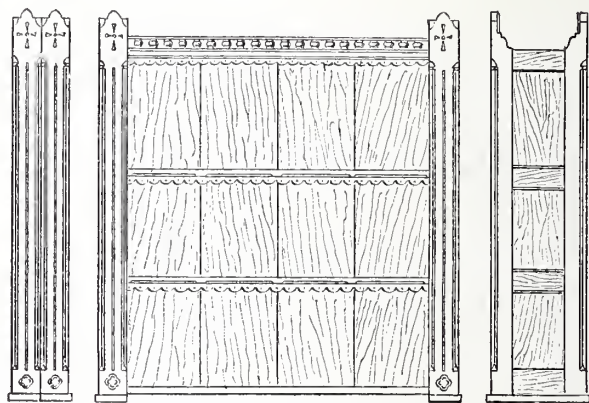


Fig. 104.—PORTABLE BOOK-CASE.

the centre of each circle. All of this may be seen by reference to the illustrations.

A portable book-case may next be taken, as shown at Fig. 104. The closed book-case, as may be seen by Fig. 105, is 4 ft. by 12 in. by 7 in., a parcel of wood that may be carried easily. For a larger book-case of this description, having more shelves to stow away, an increased recess in the ends would have to be allowed. The principal feature is the ease with which it may be folded up for carrying. Those who have occasion to frequently travel with a small library of

books will be able to appreciate the convenience of a portable book-case.

The front of the complete book-case is shown at Fig. 104. There is scope for plenty of ornamental work should it be wished, though the details are shown very plain purposely. An end view is shown on the right, on the left is a portion showing the two uprights, which form the front ends of the book-case, close together as they would be when the book-case is folded for removal. A section of the entire book-case, with the top and bottom and the two shelves shown lying against the ends, and the back partially folded, is shown at Fig. 105. When folded close the section is as shown on the left, the blank space there seen being for the reception



Fig. 105.—DETAILS OF CONSTRUCTION.

of the small balustrade shown at the top of the open front. One end of a shelf showing the tenons, which fit into corresponding holes in the ends, is shown on the right. This completes a brief description of the entire illustration.

It is so simple in construction that a tyro at cabinet work may fairly be expected to succeed in an attempt to make it. The two ends are 4 ft. long over all, and 12 in. broad. They may be plain boards or panelled, as shown in the end view; they have a strip of wood, $3\frac{1}{2}$ in. broad and 1 in. thick, fixed on the front of each, and also a strip $2\frac{1}{4}$ in. broad and $\frac{3}{4}$ in. thick on the back of each. Crosspieces are dovetailed into the bottom of these strips, back and front, of the same breadth as front stiles, less the thickness of ends. Corresponding crosspieces are mortised into the strips at top, and these strips and crosspieces convert the ends into two shallow

boxes or trays. The top board of the book-case is hinged at one end under one crosspiece, and folds down parallel to that endpiece, allowing sufficient space behind it to contain one of the shelves. The bottom board forming the lowest shelf is hinged to the crosspiece at the bottom of the other endpiece in the same manner, with sufficient space to allow the other shelf to lie behind it. Thus the two shelves and the top and bottom are arranged to lie close against the inside of each endpiece, as shown in Fig. 105.

There is still $2\frac{1}{2}$ in. space left between the top and the bottom ; this is to contain the back, which will consist of four divisions, each a little more than 9 in. broad, and these are hinged together in the manner shown in Fig. 105. The four pieces composing the back are hinged to each other, and the outer ones hinged to the back strips attached to the ends. When entirely closed, it assumes the appearance shown on the left. As the four boards which form the back are about $2\frac{1}{2}$ in. narrower than the shelves, a space is left, as shown, to contain the baluster railing. This railing is held in its place, as shown in Fig. 104, by the two rails being let into the edge of the stiles by shallow mortises. The two shelves are supported in place by short tenons, as seen on the right, corresponding holes being made in the ends to receive them. The back is made of $\frac{5}{8}$ in. wood, the ends and shelves $\frac{3}{4}$ in. wood. The uprights of the front are chamfered and channelled down the centre. The shelves have ornamental leather—common to book-cases without doors.

This book-case may be packed or unpacked in a very few minutes. When folded, as in Fig. 105, it is held together by hooks and eyes, top and bottom, and the manner of getting it opened for use is this :—Lay the parcel with the back on the floor, undo the hooks, pull the ends apart till the back is fully extended ; then the bottom is opened over to the

opposite side, and the top also to its opposite side. After the two shelves have been fitted into their holes in the endpieces, and the baluster rail fitted in the same manner, the top and bottom are then fastened by passing $1\frac{1}{2}$ in. screws through the crosspiece into each of them. The two screws being in, two other screws are passed through the back near the centre joint into each shelf, and this completes the fixing, and makes a very firm book-case.

CHAPTER IX.

MAKING A TOOL CHEST AND STOCKING IT.

HE cabinet worker who has accumulated enough tools to do even some of the work that has been described needs a place to stow them in. A tool chest is very suitable for tools that have to be moved about from place to place, and for those that have to be cleared away after working, as happens when the owner has not a workshop proper.

The reader who has followed through the preceding pages is, doubtless, sufficiently advanced in the art of wood working to be able to construct a tool chest, provided he has drawings of one, with description of its construction.

In the chest illustrated, the left-hand end of the till part is occupied with three shallow trays, one over the other, for holding the several bits belonging to the brace. These trays are very handy, as the bits can be assorted, and the trays may be lifted out to the bench when several of the bits are wanted. The remainder of the top tray in the till is lined with green baize, and holds the brace, spirit-level, gauges, squares, and other of the finer tools. The two long drawers at the bottom are used for chisels, gouges, spokeshaves, drawknife, etc., while the three upper ones are for gimlets, bradawls, compasses, pliers, and sundry small tools. In the space under the till, moulding and other small planes are arranged, as shown in Fig. 107. In front of them is a space 4 in. broad and the full length of the chest. In it long tools, such as trammels, are kept, and any planes that the back space will not admit. It is also useful for holding, rolled up, drawings of large

dimensions, where they are safe from damage, and in times of removal it is the receptacle for the hand-saws and other tools which usually hang upon the wall.

As to dimensions, these may be varied to suit individual requirements; the chest shown at Fig. 106 is 3 ft. 1 in. by 1 ft. 8 in. by 1 ft. 8 in. inside measurements, with a till the full length of the inside, 9 in. broad and $10\frac{1}{2}$ in. deep. The body

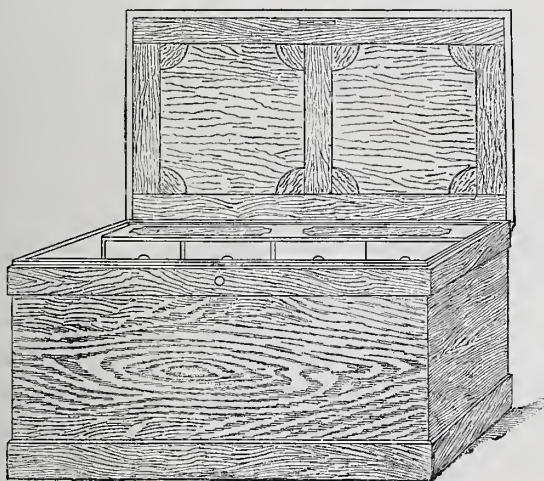


Fig. 106.—TOOL CHEST COMPLETE.

of the chest is made of $\frac{7}{8}$ in. best yellow pine, with a $2\frac{1}{2}$ -in. band of oak round the lid, and one $3\frac{1}{2}$ in. wide round the bottom. The till and the inside of the lid are veneered with rosewood and walnut.

Now, as to the construction: Good, clean yellow-pine 1 in. thick is selected, and the two sides are squared up 3 ft. 3 in. long and 1 ft. 8 in. broad, and the two ends 1 ft. 10 in. long and 1 ft. 8 in. broad. The sides and ends are “slipped” on the upper edge by the method described on page 90—that is, a thin slip of plain walnut, say $\frac{3}{8}$ in. thick, is glued on what is

to be the upper edge of each piece, and the above measurements include this slip. These four pieces are dovetailed together, the dovetails $1\frac{1}{2}$ in. apart, and all going quite through the thickness of the wood. It must be recollected, in dovetailing a box such as this, that the "pins" are always on the end pieces; consequently they are cut first. An examination of Fig. 107, which is a cross-section of the chest, shows two fillets underneath the till, these are for the till to slide upon. They are mahogany, 1 in. broad and $\frac{5}{8}$ in. thick, with a groove in the centre. They are glued and screwed to the inside of the box ends at a distance of $10\frac{3}{4}$ in. from the upper edge.

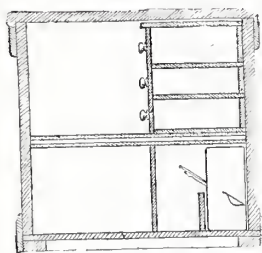


Fig. 107.—SECTION THROUGH TOOL CHEST.

The grooves receive a sliding board 11 in. wide, which slides underneath the till, and when pushed back it covers the planes and tools in the space shown under the till, and, when pulled forward, it covers the front space. This board is always fitted in a chest, though it may very well be left out, as it is often found more in the way than of any real use.

There is a partition board lengthways of the box shown under the face of the till, which comes nearly up to the sliding-board, and is fitted into grooves in the two ends. A second partition, in the middle of the space under the till, is 4 in. broad, and is also let into the ends. These two partitions are $\frac{1}{2}$ in. thick, and these grooves must be made in the ends to receive them before the body of the chest is knocked together.

All the inside should receive a stain of Venetian red and ochre, with a little glue size. This stain is made somewhat thin, and is applied hot to the clean wood with a piece of cotton rag; then, after standing for a few minutes, as much as

will come is rubbed off with another piece of rag, stroking always with the grain. In a short time, when this stain is dry, it is sandpapered, using the finest.

The chest body is now to be put together with thin glue, using a small brush for the dovetails, and taking care that no glue gets on to the inner surface, as taking it off afterwards leaves an unsightly mark. In "rapping" the body together, a somewhat heavy hammer is used, always striking upon a piece of wood to protect the work from injury. The four corners are glued and rapped up close. The box has to be squared. By the term used, rectangular is meant, as the box is not square, but oblong. A rod of wood made like a wedge at one end, and applied diagonally from corner to corner inside, is the readiest method of squaring, a pencil mark made on the side of the rod where the side and end meet; then the rod being placed diagonally across the other two corners, the pencil mark will show at once whether the box is squared or not; and, if not, the long diagonal must be pressed or pushed to bring the chest square.

A bottom of $\frac{5}{8}$ -in. wood is nailed on in strips, with the grain running from back to front. Then a strip of wood $2\frac{1}{2}$ in. broad, and 1 in. thick, is nailed all round the bottom, and flush with the outside of the box. The two long strips are nailed on first, and the end ones are fitted between them. To secure these strips properly, a few $1\frac{1}{4}$ in. screws should be passed into them through the bottom from the inside.

The chest has now to be planed truly on the outside all round, finishing with a hand plane and sandpaper. Then one band is made to go all round outside at the bottom, and another $\frac{3}{8}$ in. from the top or upper edge; that at the bottom is $3\frac{1}{2}$ in. broad and $\frac{5}{8}$ in. thick, and that at the top $2\frac{1}{2}$ in. broad and $\frac{5}{8}$ in. thick. It is best to dovetail these bands at the corners, making them the size to slip exactly on to the body of the

chest. The upper edge of the bottom band, and the lower edge of the upper, are moulded either with an ogee or quarter round. When the bottom band is in a position for nailing, it covers the strips round the bottom and the edge of the bottom, coming up the sides of the chest about 2 in. The upper band is fixed $\frac{3}{8}$ in. below the edge of the body; this forms a check for the lid, the banding round the lid being made to fit down on this.

The lid is made of pine, $\frac{7}{8}$ in. or 1 in. thick; it has end clamps $2\frac{1}{2}$ in. broad mortised on. These prevent the lid splitting or warping. After they are glued and cramped on and dry, the lid is evenly planed and squared to the proper size, which is $\frac{1}{16}$ in. larger than the body of the box on front and ends, and $\frac{1}{4}$ in. over the back. In the illustration, Fig. 106, the inside of the lid is shown panelled. This panelling is simply a flat veneered surface, the two panels being root walnut, and the borders rosewood; and this veneering must be done before the skirting mentioned below is put on. The two panels are laid first, and when dry the cutting gauge is set to $2\frac{1}{4}$ in., and cuts away the over veneer all round, which gives a border of $2\frac{1}{2}$ in. to be veneered with the rosewood; there is $2\frac{1}{4}$ in. between the two panels in the centre, and the eight corners are marked off with compasses set to $1\frac{1}{2}$ in., and cut clean out with a gouge. All the edges are now smoothed with the iron plane, and the rosewood border planed and butted all round. The rounded corners may be fitted in in two pieces mitred in the centre, and much embellishment can be given to this veneering.

The lid should now be fitted with three hinges; these are brass butts 3 in. long. Being temporarily fitted, the lid is taken off, and a skirting put round it on front and ends. This is $1\frac{1}{4}$ in. broad, and $\frac{7}{8}$ in. thick, of hard wood—oak or black birch. This skirting should be grooved, and also the chest-lid

and slip feathers inserted. It should also be glued and nailed with fine wrought brads. After it is firmly fixed and dry, it is rounded on the outer edge. The extent of the rounding is found by shutting down the lid and drawing all round at the edge of the band, over which the skirting projects about $\frac{5}{16}$ in.

The till has now to be made, Fig. 108 shows the face side of it. It has two drawers filling the whole length at the bottom; they are 3 in. deep on the face, 3 in. in the centre, $2\frac{1}{2}$ in. deep on the face, and over these is a tray, covered by the hinged lid; this is deep enough to hold the brace, or tools of the like bulk. The face of this tray is shown in Fig. 108 as four drawers, which are, of course, shams. The body or carcase of this till is

made entirely of $\frac{1}{2}$ -in. wood, and is constructed as follows:—

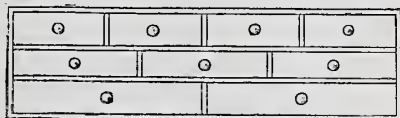


Fig. 108.—TILL OF TOOL CHEST.

The two ends have clamps on the upper edge; these are $1\frac{1}{4}$ in. broad, and may be put on with the ploughs. Then the bottom and two shelves are squared up to the length of inside of the chest, having been previously slipped on the fore-edges with rosewood $\frac{1}{8}$ in. thick. The bottom is dovetailed into the two ends, while the two $\frac{1}{2}$ -in. shelves are mortised into the ends, or let through with square tenons, which pass quite through, and are wedged. The divisions $\frac{1}{2}$ in. thick between the drawers are let through, and wedged in the same manner. The front of the tray, which has the appearance of four drawers, is of $\frac{1}{2}$ -in. mahogany, veneered with root walnut, like the drawer fronts, and an imitation of the fore-edges made on it by glueing slips of rosewood, $\frac{1}{2}$ in. broad, to represent the edges. The walnut front must be sandpapered before these are put on.

The five drawers are made entirely of bay mahogany, $\frac{1}{4}$ in.

thick, excepting the fronts, which are $\frac{1}{2}$ in. The nine knobs are of rosewood, $\frac{3}{4}$ in. diameter. All these drawers are 9 in. from front to back, and run on shelves $\frac{1}{2}$ in. thick, with divisions between of the same thickness. The shelves, divisions, and the edge of the lifting lid, are each slipped with rosewood on the fore-edges, and the drawers being veneered with root walnut the whole has a good effect. The lid may be made of bay mahogany or good pine; if of the latter, it must be veneered on the under side with plain walnut or mahogany, to counteract the veneer on the top and prevent warping. The lid is panelled with veneer on the under side similar to the lid of the chest, the rosewood border being $1\frac{1}{2}$ in. broad. It is hinged with three brass butts, $1\frac{1}{2}$ in. long, to the back of the till, which projects upwards the thickness of the lid, and is veneered also with rosewood.

As there are several sliding parts in this chest, a small block of hard white soap should be procured, and when drawers or sliding parts of any sort are quite finished, rub with the soap all parts that come in contact with, as well as the guides and interior parts of the case subject to friction from, the drawers. This soap will, in a short time, get very hard, if kept dry; and the harder the better, as when soft it is apt to give a stickiness to the parts rubbed with it. Any drawers or sliding parts so treated will move very much more sweetly and easily; but let it be borne in mind that in order that a drawer may move easily and pleasantly, it must be properly fitted in the making, as no amount of soaping will make a good fit of an ill-fitted drawer.

The chest, when finished, is painted according to the fancy of the owner. It is generally a plain dark brown. Many chests are fitted with a spring lock—that is, when the lid is shut down the key must be used in order to open it again. When the chest is finished in the painting, a pair of strong

iron handles are put on the ends, a covered shield over the key-hole, and it is finished.

Having completed our tool chest, it may be as well to consider something as to the best assortment of tools with which to stock it. If the reader has already accumulated some tools by acquiring as occasion required a particular tool to do a particular job, he will not now need all those enumerated in the following lists. Also he must modify the lists in accordance with his special kind of work.

The beginner will be glad to see the stock of tools recommended for use in wood-working in the principal handicraft schools; and the following form useful lists for consultation before equipping a tool chest. It is well to always bear in mind that individual requirements may considerably modify the list of tools best suited. The dimensions of the tools chosen may differ according to the tastes of the user, and to the fineness or coarseness of the work he executes.

The tools enumerated as most essential for exercises in wood-working for handicraft classes at the Central Institute of the City and Guilds of London are :—

The Bench, provided with a vice and bench stop; and an iron cramp, called a holdfast, is useful.

Grindstone, about 24 in. diam., and 4 in. width of face; generally mounted on an iron frame and worked by foot.

Glue pot.

Nails and screws assorted in a nest of drawers.

A mitring board, a sluting board, one or two mitring blocks, a straight edge or two, and two or three pairs of truing sticks, are convenient for common use in the shop.

The following is a list of the most essential tools required by each pupil. The set costs about 26s. to 28s.

1 plane, 17 in. long, ground more like a trying plane than a jack plane.

1 smoothing plane.

1 14-in. tenon saw.

8 firmer chisels.

1 4½-in. rosewood square.

1 2-ft. rule.

- 1 hammer, medium size.
- 1 marking gauge.
- 1 screw-driver.
- 3 gimlets, 3 bradawls, 1 brad-punch.
- 1 marking point.
- 1 spoke-shave.

In order that these may suffice for a class of about twenty-five, the following tools should also be provided :—

- 3 mallets.
- 3 24-in. panel saws.
- 3 oil-stones, and oil can.
- 1 joiner's cramp.
- 1 set of $\frac{1}{8}$ -in. letters for marking tools.
- 2 sawing trestles.

For practical work at the Polytechnic, London, it is recommended that the workshop should be furnished with the following tools :—

- Double-bench, 10 ft.
- Grindstone, 24 in., mounted in trough.
- Glue pot, glue and glue brush.
- Cramp, wrought iron. 2 hand screws.
- 2 sawing stools.
- Planes :—Trying, 22 in. long ; jack, 18 in. long ; smoothing ; 6 hollows ; 6 rounds ; rebate, $\frac{3}{4}$ in. ; plough, and set of 8 irons, $\frac{1}{8}$ in. to $\frac{5}{8}$ in. ; router.
- Saws :—Half rip, 3 teeth per in. ; hand, 4 teeth per in. ; tenon, 8 teeth per in. ; dovetail, 15 teeth per in. ; bow.
- Chisels :—10 firmer, $\frac{1}{8}$ in. to $1\frac{1}{2}$ in. ; 4 mortise, $\frac{5}{16}$ in. to $\frac{1}{2}$ in.
- 2 gouges, small and medium.
- Oilstone, slow cutting ; arkansas slip for sharpening hollows ; oil-can and salad oil.
- Rule, twofold, 2 ft.
- Square, 6 in. (the stock cut 45° to mark mitres) ; bevel, with steel blade ; setting-out knife.
- Hammers, large and small ; mallet.
- 3 gimlets ; 3 bradawls.
- 2 punches.
- 1 pair of pincers ; 1 pair of compasses.
- 2 screw drivers, a small and medium.
- Brace, and set of assorted bits.
- Spokeshave, small.
- Gauges :—Mortise, marking, and cutting.

For a course of study and practice in bench work, in wood

designed for the use of schools and colleges in the United States, the equipment necessary for carrying out the course of practice is much less expensive than may at first appear. Besides a bench, a pair of trestles, and a bench-hook, the following named tools are needed :—

- 1 2-ft. rule.
- 1 framing square.
- 1 try square, 7 in.
- 1 bevel, 8 in.
- 2 marking gauges, 8 in.
- 1 chalk line, with chalk.
- 1 lead pencil.
- 1 scribe.
- 8 firmer chisels, 1 each, $\frac{1}{8}$ in., $\frac{1}{4}$ in., $\frac{3}{8}$ in., $\frac{1}{2}$ in., $\frac{5}{8}$ in., $\frac{3}{4}$ in., 1 in. and $1\frac{1}{2}$ in.
- 4 gouges, 1 each, $\frac{3}{8}$ in., $\frac{1}{2}$ in., $\frac{3}{4}$ in. and 1 in.
- 1 cross-cutting saw, 22 in., 8 teeth per in.
- 1 ripping saw, 24 in., 6 teeth per in.
- 1 back saw, 10 in.
- 1 drawing knife, 8 in.
- 1 fore-plane.
- 1 jack-plane.
- 1 smooth-plane.
- 1 set auger bits, $\frac{1}{4}$ in. to 1 in. by 16ths.
- 1 bit brace.
- 1 bradawl.
- 1 carpenter's hammer.
- 1 mallet.
- 1 nail set.
- 1 oil-stone.

Also the following ; but if provision is to be made for more than one student, these items need not be duplicated. One set of these will suffice for any number less than twenty.

- 1 pair dividers, 8 in.
- 1 pair matching planes, $\frac{3}{8}$ in.
- 2 beading planes, each $\frac{7}{8}$ in. and $\frac{1}{4}$ in.
- 1 plow.
- 1 hand scraper.
- 6 quill bits assorted from $\frac{1}{4}$ in. down.
- 1 mitre box.
- 1 grindstone.

With these lists of the tools to consult, selected for the purposes named, by the authorities of the recognised leading Handicraft Institutions the reader may readily determine which tools he will find suit his wants. It is perhaps advisable to mention, in conclusion, that tools of *good* quality should always be chosen. The common tools sold at absurdly low prices by some ironmongers and tool dealers often prove to be useless, and therefore dear at any price.

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